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SILAGE MAKING BY THE HOT AND COLD PROCESSES.

An extract from the Inaugural Thesis, entitled "The Historical Development of the Conservation of Green Fodder by Ensilage," prepared by Dr. H. Krause, Dr.Phil.Nat., as part of the requirements for the Degree of Doctor in the Faculty of Higher Mathematics in Natural Science at the State University of Thuringia at Yena.

Prepared from the Author's Translation by Geo. L. Sutton,
Director of Agriculture.

Green fodder crops can be conserved in two ways—by drying and by making them into silage. The oldest and commonest method of conservation of green fodder is by drying in the air, as is customary in the ordinary process of hay-making. In this way the water content of the green material is reduced from 70 to 80 per cent. down to 10 to 13 per cent. This method is the simplest and most natural way of conserving green fodder. If it were possible to utilise this excellent method of conservation during any part of the growing period, and under all climatic conditions, without great losses in food value, then this natural system of air drying would be unquestionably the best. In the temperate zone, however, the losses in food value, as the result of making hay, are high, even during good weather and with plants which dry quickly.

Experiments to study the losses which occur during the process of air drying have been carried out by Professor Wiegner, of Zurich. According to these experiments the losses under favourable weather conditions amount to 40 per cent. of the starch equivalent, and range from 14 to 40 per cent. of crude protein.

The most efficient system of conserving green fodder is by artificial drying. The result is a product which will keep indefinitely and sells readily. Legumes artificially dried, for instance, are found to be valuable concentrate, rich in protein. The disadvantages of artificial drying are the high costs involved, as to dry grass containing 1 cwt. of starch equivalent (11 cwt. grass) 2 cwt. of coke were found to be necessary.

Later experiments dealing with the presence of vitamins show that a number of vitamins are partly or completely lost during the process of hay-making. Thus in this direction also the food value of the hay is considerably less than the food value of the original green fodder.

Another section of these experiments showed that the loss of vitamins is very much less when the same green fodder is made into silage, and also that the modern method of making good silage is associated with comparatively small losses of the starch equivalent, or the energy value of the food.

It will thus be seen that the transformation of green fodder into silage, when properly carried out, is to be preferred to hay-making because of the relatively small loss of food value, including the very small losses of vitamins which occur when the crops are conserved as silage.

The many methods followed by farmers in making silage can be grouped under two different systems, namely, what are known as—

(a) the cold fermentation system, and

(b) the warm fermentation system.

Under the system of **cold** fermentation the freshly cut green fodder is placed in the pit or silo, and is packed by tramping as quickly and as firmly as possible, so as to drive out, without delay, the maximum quantity of air from between the stems and leaves. The oxygen of the small quantity of air which then remains is absorbed by the plants themselves by respiration (breathing) and without any great rise in the temperature of the mass. Usually the rise in temperature does not exceed 10° Fah. After a short period of intra-molecular respiration the plants die by suffocation; during this period small quantities of organic acid are developed by incomplete oxidisation. After this, as the result of the development of certain lactic acid bacteria, especially *Bacterium cucumeri fermentati* and *Bacterium lactis acidi*, a part of the soluble carbohydrates is transformed chiefly into lactic and other organic acids. When the concentration of acid reaches about two per cent. of the total volume of the silage, fermentation stops and the green fodder is then preserved as the result of the acid formed.

When it is intended to use the **warm** fermentation process of making silage, it is necessary that the green crop be allowed to wilt after cutting, until the water contents are reduced to between 65 and 70 per cent. The silo or pit is then filled slowly, and without packing, at the rate of from three to six feet each 24 hours. Under such conditions there is an abundance of air amongst the greenstuff, and this is used by the plants for intensive respiration, and, in consequence, the result is a great rise in temperature. When the temperature rises to over 120° Fah. the mass of silage is firmly packed by tramping, or by the application of pressure by other means.

The high temperature of the silage resulting from rapid respiration of the plants, and the work of the thermophilic (heat loving) bacteria causes the death, by heat, of the green plants and of many heat sensitive micro-organisms. Those which are killed do not, however, include the so-called warm lactic acid bacteria, *e.g., Bacterium kolbrucki, Bacterium bulgaris,* and certain *Streptococcus spp.* The optimum temperatures at which these bacteria flourish lie between 105° and 120° Fah., and they are able to live in the absence of air, that is, they are anaerobic. The pressure applied to the material in the silo drives out the air, and this condition, combined with the temperature prevailing (not exceeding 120° Fah.) provides favourable conditions for the warm lactic acid bacteria to develop.

As the result of the pressure being applied the air is driven out, the temperature ceases to rise and slowly declines. The slow fall in temperature is important, for it is very desirable that, as the result of the activities of the warm lactic acid bacteria, the acid contents of the silage mass should have reached from one to one and a-half per cent. by the time the temperature falls to 105° Fah. This degree of

acidity stops the fermentation and the silage is conserved. Unless acid is developed to this extent before the temperature falls below 105° Fah., the butyric acid bacteria become active under the anaerobic (without air) conditions and produce a foul-smelling silage, with the odour of rancid butter and of decreased feeding value. The butyric acid bacteria flourish at temperatures ranging between 95° to 105° Fah., and can even form spores at higher temperatures.

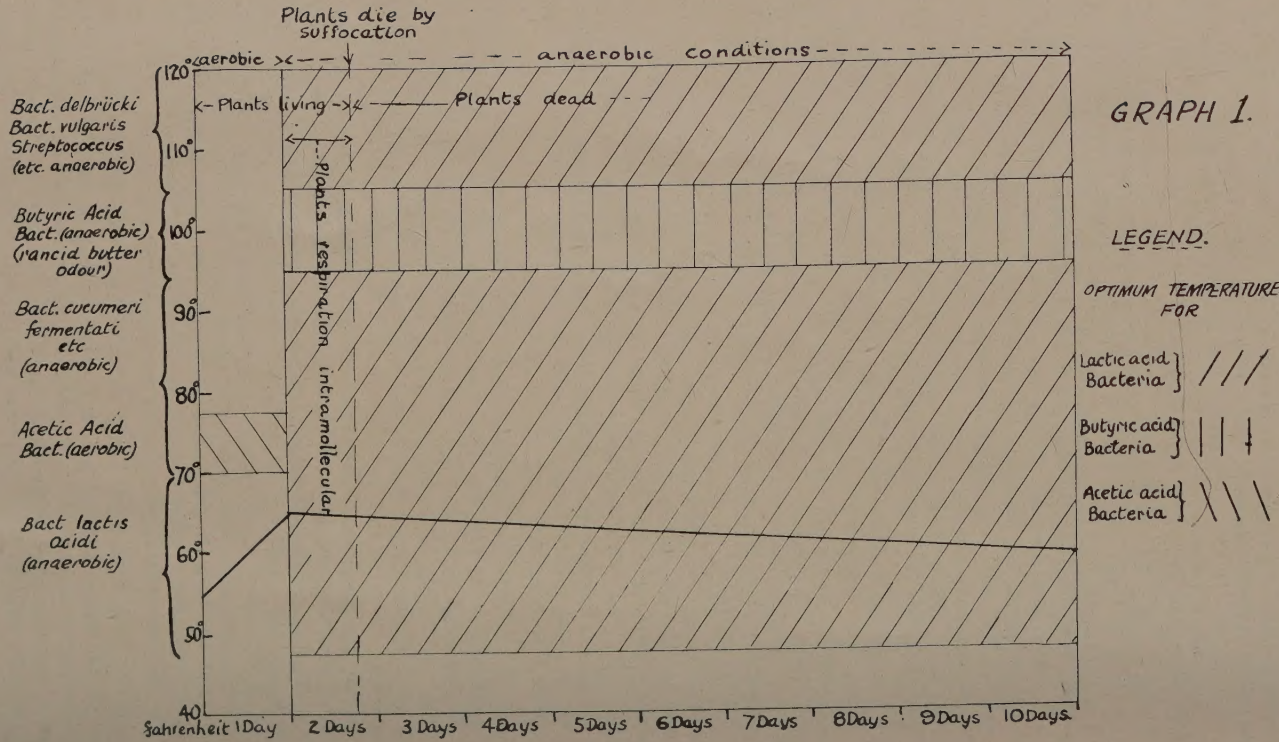
By the adoption of the cold fermentation method it is easy, provided it is properly done, to keep the temperature *under* the optimum temperature for the growth of the butyric acid bacteria. The risk of forming butyric acid in the silage is, therefore, very much greater when the warm fermentation method is used than when the cold one is adopted. Under the warm fermentation method the only chance of preventing the formation of butyric acid is for the temperature to be kept between 105° and 120° Fah. for sufficiently long to allow for the development of about one and a-half per cent. of lactic acid, and to stop the fermentation. Obviously, to control the temperature until the proper degree of acidity is reachd is not easy, and very often will be impossible.

The undesirable development of acetic acid bacteria, which are aerobic, *i.e.*, need air for their development, is also very easily prevented by the adoption of the cold fermentation method with the exclusion of air. It is comparatively easy to create anaerobic (without air) conditions as the result of tramping the green material is firmly as possible immediately it is placed in the silo or pit; this thorough packing drives out the air in the mass of green material and excludes the entry of fresh supplies.

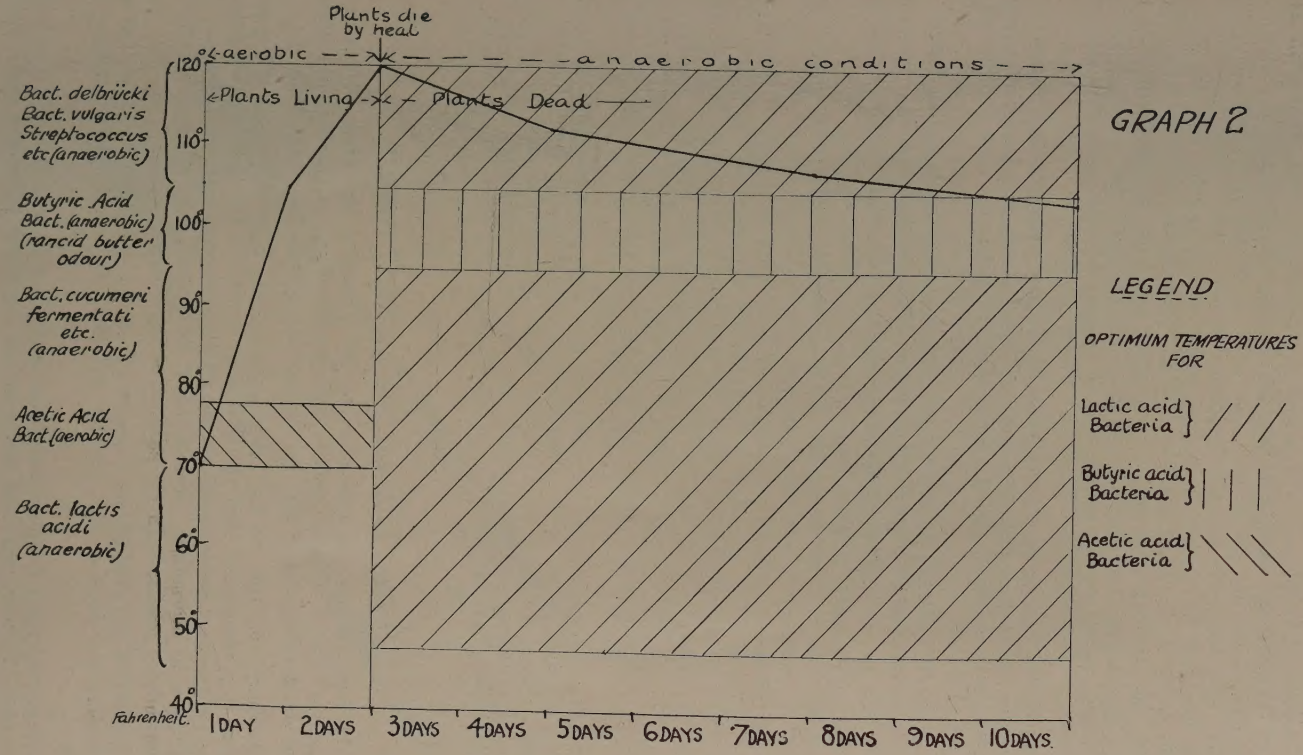
The two graphs herewith illustrate the changes that take place under the two methods. On the horizontal line the number of days (one to nine) from the commencement of the process are shown. On the vertical line the temperatures reached are shown. The optimum temperatures of some of the types of bacteria referred to are also given; the optimum temperatures for the lactic acid bacteria are shown thus /////; those of the butyric acid bacteria thus |||||, and those of the acetic acid bacteria thus \\\\\.

Graph No. 1 shows the changes resulting from the cold fermentation method. The temperature of the crop on going into the silo was 55° Fah. As the result of the firm packing at the time and the respiration of the plants, a rise in the temperature was found to occur only during the first day. After the end of this day the temperature had risen to 65° Fah., that is, lower than the optimum temperature of the acetic acid bacteria, which is from 70° to 80° Fah. During the second day the remainder of the oxygen in the air was used up, and the establishment of anaerobic conditions were completed. This prevented the further formation of acetic acid for the bacteria responsible, for this cannot develop under anaerobic conditions. After a short period of intra-molecular respiration the plant cells died of suffocation. Following this the temperature fell very slowly, and remained for a period of at least eight days within the optimum temperature of the cold lactic acid bacteria. It will be noticed that the optimum temperature for the anaerobic butyric acid bacteria was not reached during the process and hence the unpleasant smell caused by these bacteria was not generated.

Graph No. 2 represents the results of the warm fermentation method. The temperature at which this material was taken to the silo was 70° Fah. This was as the result of the partial drying which the material received in the paddock after being cut and prior to being placed in the silo. Because of the loose packing at the outset the respiration of the plants was intense, and, as the result of this, the temperature rose quickly, reaching 120° Fah. by the second day, and the



The Cold Fermentation System.



The Warm Fermentation System.

plants were killed by the heat. The material in the silo was then packed and as much of the air forced out as possible; the conditions became largely anaerobic. Under these anaerobic conditions, and with a temperature between 105° and 120° Fah. the warm lactic acid bacteria developed and formed lactic acid. During this process the temperature decreased slowly, and on the ninth day reached, as shown on the graph, the optimum temperature of the butyric acid bacteria. As already pointed out, it is important that prior to this the lactic acid contents should have reached one to one and a-half per cent., otherwise the butyric acid bacteria would develop butyric acid and more or less decrease the value of the silage.

In practice the cold fermentation method provides a much better opportunity and a safer means of producing good silage. Some of the most important points which have to be watched carefully to get the best results with the cold fermentation method are:—

1. To have the right kind of green feed, *e.g.*, cereals or mixed pasture.
2. To cut it at the right age, *e.g.*, oats in the milky stage.
3. To cut it evenly and well with a silage cutter or chaff cutter, so that it will pack readily.
4. To pack it as quickly and as firmly as possible in silos or in pits so as to drive out and exclude the air.
5. To prevent further access of air to the material in the silo. To achieve this it is necessary, if earthen pits are used, to cover the silage quickly and make it air-proof, not only on the top, but also on the sides. As the silage in a pit silo packs itself more closely together it is also necessary, especially in the first weeks, to fill up the openings or cracks which appear in an earth covering on the top; this should be done every day if necessary.

Another important point which may be seen from an examination of Graph No. 1 is the maintenance of the silage at a cool temperature, so it is advisable, if possible, to build the silo or pit in a shady place. No rainwater must run into the silo or pit. Because of this, adequate cover must be provided, and, in the case of the pit-silo, drainage by means of a trench around the pit would often be useful.

"THE JOURNAL OF AGRICULTURE"

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CATCHING AND INTRODUCING QUEENS.

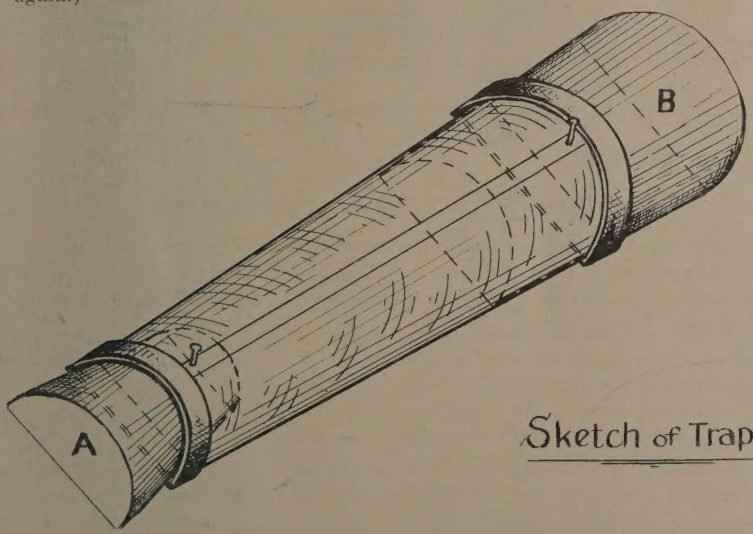
H. Willoughby Lance,
Apiculturist.

The catching of a queen for placing in another hive or in a mailing cage is to beginners a difficult operation. Even with experienced beekeepers there is the possibility that the queen, being full of eggs, may be slightly injured and her egg-laying thereafter affected, even causing the bees to supersede her.

For this reason alone, apart from the likelihood of a queen that has been handled taking a strange odour into the hive, which may cause balling, I consider that a queen should not be handled more than is absolutely necessary, such as when it is desired to clip the queen's wings.

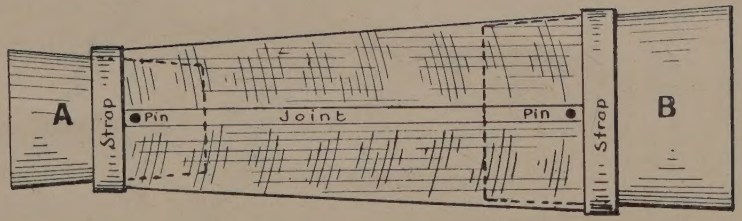
Queens reared by our Department are never handled from the time they are hatched to the time they are sent away from the apiary To enable this to be done we use a queen catcher, which may be of interest to apiarists.

This is made of fine wire gauze, commonly called in Australia "fly wire," as shown in sketch. First, two strips of tin about ¼in. wide are cut for the end pieces, bent to shape and soldered; a strip of fly wire 4in. long is next cut and bent to shape, one end to fit the large tin end piece and the other the small end piece; this is then soldered down the join and to the end pieces. Plugs of wood are then cut to fit each end, pushed into place, holes drilled through the tin and wood to take a nail to prevent the plugs falling out. (Before I used these nails, I once lost a very fine queen which I had caught and was carrying in my pocket. When I took the cage out of my pocket the large plug was out, as also was the queen. The plug was still in my pocket but the queen was not, and hunt as I would I never found her again.)



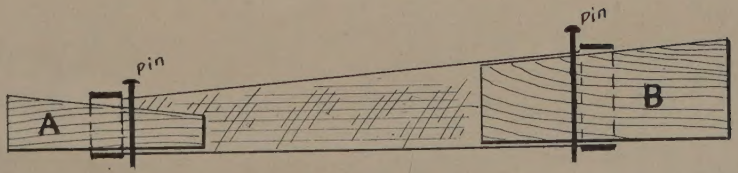
Sketch of Trap

The catcher is used as follows: Take the large plug out and lay in a handy place by the hive. Find the comb with the queen on and lay on top of hive; take the cage in left hand and plug in right; place the cage in front of queen when

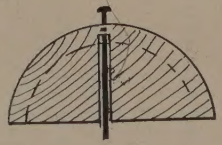


Plan of Trap showing Plugs
— A and B —

Section of Plug A



Section of Trap



Section of Plug B

walking; give the bees at back of queen a push with the plug to hurry the queen into the catcher; then put the large plug in and don't forget the nail. By this means several bees may be caught with the queen.

To get the queen out quickly the long plug must be used. When the queen is at the small end, remove the large plug and insert the long plug, carefully pushing this in so as not to catch any bees. This should go in to within about an inch of the small plug. When this is removed, the queen and bees will quickly go out at the small end.

With regard to the introducing of queens, there is one method which I have never seen referred to in any Bee Journal; whether it is used by many I do not know. It is what I call the "paper bag" method. I always use it, and only on one occasion did it fail, and this was my own fault. Take a small thin paper bag, such as is used for sweets. Place in this bag, by herself, the queen to be introduced. Remove the old queen from the hive. Catch half a dozen young bees that are filling up with honey at the cells and place them in the bag with the queen. Queen and bees are so anxious to get out that there is no trouble. Screw up the end of the bag and place between the frames. The queen will be released in a very short time and no queen cells will be built, and it will not be necessary to hunt for these later. The whole job has been done in one operation, but of course it is advisable to examine the hive four or five days later to ensure that the queen is "O.K." and laying, as there is the possibility but not the probability of something having gone wrong. Of course, when the old queen is caught, the combs should be examined to make sure there are no queen cells.

WESTERN AUSTRALIAN F.A.Q. WHEAT.

ANALYSES OF SAMPLES.

R. P. ROBERTS, B.Sc.Agri. (Hons.), Agricultural Adviser.

The mechanical and chemical analyses of the F.A.Q. standard for the five seasons 1928/29 to 1932/33 are given in the accompanying table. The chemical analyses were carried out by the Government Analyst's Department:—

	1928/29	1929/30	1930/31	1931/32	1932/33
	%	%	%	%	%
Moisture	11.94	10.41	12.00	8.98	10.51
Declared bushel weight	62¼	62½	62½	61¾	62
Impurities and screenings	3.00	3.60	3.96	3.87	3.44
Total millable grain	97.00	96.40	96.04	96.13	96.56
Protein (N. × 5.7)	..	..	..	10.00	9.92
Ash	..	..	..	1.42	1.70
Products—					
Flour	71.3	71.5	70.7	71.0	71.0
Bran	19.2	19.9	19.7	19.3	19.6
Pollard	9.5	8.6	9.6	9.7	9.4
Flour—					
Water absorption	54.50	54.75	55.75	55.00	53.0
Protein (N. × 5.7)	8.70	9.52	10.14	10.80	8.78
Gluten—Wet	25.81	24.70	30.36	29.50	24.88
Dry	8.23	8.45	10.01	10.12	9.90
Hydrated maltose	..	..	..	..	1.49

HERD TESTING.

THE OFFICIAL AUSTRALIAN PURE-BRED DAIRY CATTLE PRODUCTION TESTING SCHEME, 1932–33.

The results for the following cows were not available in time for publication in the last Journal, and complete the list published therein :—

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date. of Calving.	No. of Days in Test.	Weight of Milk Last day of Test.	Weight of Milk for period.	Average Test.	Butter Fat.	Owner.	Sire.
						lb.	lb.	%	lb.		
MATURE COWS (OVER 5 YEARS OLD)—STANDARD 350 LBS. BUTTER FAT.											
Denmark Rose Dame	Guernsey	1794	19–8–27	24–8–32	273	27	10168	4·5	454·78	Denmark State Farm	Rose Chief of Wollongbar
Nancy 9th of Raleigh	A.I.S. ...	15719	30–4–29	12–8–32	273	16	8658	4·8	419·03	D. Bevan	Union Jack of Raleigh
Blanche 4th of Minathorpe ...	do. ...	15114	16–7–25	27–8–32	240	7	9255	4·4	396/51	R. Bee & Sons ...	Collier of Darbalara
Blanche 5th of Minathorpe ...	do. ...	17936	16–5–26	30–8–32	273	16	8778	4·3	375·16	R. Bee & Sons ...	do. do.
Topsy Rye of Grass Vale ...	Jersey ...	15702	1–7–23	8–9–32	240	12½	7035	5·3	370·58	C. H. Ironmonger ...	Rye Duke of Glen Iris
Banyule Velveteen 12th ...	do. ...	24474	11–9–27	17–9–32	273	17½	7022	5·2	367·59	Sabina Vale Stud ...	Wotton Airman
Wooroloo Gem	A.I.S. ...	15143	28–9–26	2–10–32	273	19	8157	4·5	364·95	Wooroloo Sanatorium Farm	Commercial of Black Heath
Banyule Silvermine 38	Jersey ...	18817	19–10–25	29–9–32	273	19½	6753	5·2	352·13	Sabina Vale Stud ...	Wotton Airman
Springmead Flower Girl ...	do. ...	13876	25–2–23	7–9–32	273	20	8400	4·1	344·47	Sabina Vale Stud ...	Springmead General
Grangelea Buttercup	do. ...	26388	21–3–27	5–9–32	273	17½	6517	5·0	337·82	Sabina Vale Stud ...	Grangelea Dairy's V.C.
Wollongbar Golden Pearl 5th ...	Guernsey	1128	8–9–24	21–9–32	273	13	5289	5·3	282·89	Muresk Agricultural College	Judge of Wollongbar
Brookvale Noble Lass	Jersey ...	20866	2–8–25	2–9–32	240	15½	5580	5·0	277·98	G. F. Combs ...	Noble Lad of Roelands
Denmark Rosa	Guernsey	1429	15–12–25	9–8–32	273	14	5952	4·6	277·44	Denmark State Farm	Rose Chief of Wollongbar
Shiela 2nd of Sarnia	Jersey ...	20862	10–1–25	24–8–32	180	13½	3300	5·3	176·94	F. P. Atwell	Werribee's Starbrights Butterking
Girlie 4th of Sarnia	do. ...	17943	16–8–24	16–10–32	120	17½	2940	...	125·88	F. P. Atwell	do. do. do.
COW OVER 4½ YEARS AND UNDER 5 YEARS OLD—STANDARD 330 LBS. BUTTER FAT.											
Limelights Camellia of Wongara	A.I.S. ...	17879	24–7–27	19–4–32	273	28	10464	4·2	429·55	W. G. Burges ...	Limelight of Darbalara
COWS OVER 4 YEARS AND UNDER 4½ YEARS OLD—STANDARD 310 LBS. BUTTER FAT.											
Victress of Toora	A.I.S. ...	17867	7–3–28	9–8–32	273	28	10074	4·7	475·48	W. G. Burges ...	Victor of Darbalara
Empress 4th of the Hill ...	do. ...	15703	26–5–28	20–9–32	273	27	10821	4·3	431·56	W. G. Burges ...	Crescent of the Hill
Glenoshea Ada	Jersey ...	28492	3–8–28	26–9–32	273	19	6657	4·8	318·74	Sabina Vale Stud ...	Burnside Moolton
Spangle 8th of the Hill ...	A.I.S. ...	15749	17–4–28	9–9–32	273	12½	7192	4·4	315·06	W. G. Burges ...	Crescent of the Hill
Karridale Lady Biddy ... —	Guernsey	2332	29–5–28	6–8–32	273	12½	5902	5·1	307·75	E. D. P. Hayes ...	Minnamurra Oliver Twist
Pendant of East View	A.I.S. ...	18339	18–6–28	1–8–32	210	19	6635	3·6	236·80	A. E. Grant	Sultan of East View
Woodendale Lassie	Jersey ...	...	14–6–28	10–9–32	150	12½	3195	...	138·90	F. P. Atwell	Mokine Lady's Chief

COWS OVER 3½ YEARS AND UNDER 4 YEARS OLD—STANDARD 290 LBS. BUTTER FAT.

Juadine Peerless Lily 3rd ...	Jersey —	28183	29-9-28	27-9-32	273	19	7557	5·8	443·67	Miss L. Hancock ...	Larry of Duadine
Karawara Lofty 2nd	A.I.S. ...	15950	5-2-29	8-9-32	273	27	9411	4·1	390·11	W. G. Burges ...	Sailor of Karawara
Juadine Sparkle 3rd	Jersey ...	28185	15-9-28	14-9-32	273	15	7050	4·9	346·84	Miss L. Hancock ...	The Valley Twilish Fox
Telyarup Dalla 2nd	A.I.S. ...	2503	11-11-28	23-7-32	273	11	8238	3·9	324·51	A. E. Grant	Baron of Darbalara
Karridale Royal Lady	Guernsey	2333	10-10-28	4-8-32	273	11	6168	5·3	319·96	E. D. P. Hayes ...	Minnamurra Oliver Twist
Claremont Biddy 9th	A.I.S. ...	...	18-8-28	5-8-32	273	16	8178	3·7	307·71	Hospital for Insane ...	Clinker of Claremont
Mokine Empire Lily 13th ...	Jersey ...	...	2-11-28	22-9-32	273	12	4986	5·3	264·39	T. H. Wilding ...	The Valley Twilish Fox
Woodendale Shirley	do. ...	28175	8-7-28	5-7-32	210	11½	4725	5·2	247·38	F. P. Atwell	Mokine Lady's Chief

COWS OVER 3 YEARS AND UNDER 3½ YEARS OLD—STANDARD 270 LBS. BUTTER FAT.

Juadine Daisy 2nd	Jersey ...	34342	24-6-29	9-8-32	273	19½	8188	4·8	388·82	Miss L. Hancock ...	The Valley Twilish Fox
Claremont Star 2nd	A.I.S. ...	...	1-8-29	16-8-32	210	14½	6225	4·0	250·08	Hospital for Insane ...	Claremont Elector
Minnamurra Eleanor	Guernsey	2607	13-8-29	20-9-32	273	15	4875	4·0	213·02	Muresk Agricultural College	Caramara Favour

COWS OVER 2½ YEARS AND UNDER 3 YEARS OLD—STANDARD 250 LBS. BUTTER FAT.

Burnside Myrtle	Jersey ...	...	29-10-29	26-8-32	273	15½	5807	5·0	293·23	E. D. P. Hayes ...	Minnamurra Prairie Don
Grassvale Golden Cream 3rd ...	do. ...	...	26-8-29	22-7-32	273	12	5586	5·2	289·62	R. H. Rose	Choice Goods of Garden Hill
Claremont Star 3rd	A.I.S. ...	5124	16-2-30	23-8-32	273	20½	6826	4·1	280·65	Hospital for Insane ...	Claremont Evan
Grassvale Choice Maid	Jersey ...	34812	10-10-29	5-9-32	273	18	4674	5·4	253·69	R. H. Rose	Choice Goods of Garden Hill
Claremont Maggie Morrison 8th	A.I.S. ...	5121	28-1-30	16-8-32	273	11½	5779	4·1	237·31	Hospital for Insane ...	Searchlight of Sunny Vale
Minathorpe Blanche 8h ...	do. ...	2474	20-10-29	10-9-32	273	8½	4840	4·8	224·17	R. Bee & Sons ...	Collier of Darbalara
Lonswood Lady Grey 9th ...	Jersey ...	...	14-9-29	27-8-32	273	9	4252	4·9	207·98	B. W. Prowse ...	Hamel Lea Fancy's Dapper
Tipperary Virginia 4th ...	A.I.S. ...	2379	18-8-29	17-8-32	150	28	4620	...	192·21	W. G. Burges ...	Melba's Re-Echo of Tipperary

COWS UNDER 2½ YEARS OLD—STANDARD 230 LBS. BUTTER FAT.

Brookvale Bluebell	Jersey ...	...	21-6-30	17-7-32	273	14½	6073	5·06	303·54	G. F. Combs	
Longridge Bess	A.I.S. ...	5104	15-8-30	7-10-32	273	13	5439	5·10	284·89	R. Bee & Sons ...	Minnathorpe Kitchener
Glanavon Edna	do. ...	2353	10-7-30	23-9-32	273	13½	6115	4·5	269·01	D. Bevan	Raleigh Regent
Brookvale Double Success ...	Jersey ...	...	24-7-30	19-7-32	273	14½	5923	4·4	262·69	G. F. Combs	
Mokine Empire Breakaway ...	do. ...	...	5-9-30	26-9-32	273	12	4656	5·3	250·12	T. H. Wilding ...	The Valley Twilish Fox
Claremont Lily 4th	A.I.S. ...	5120	1-3-30	26-8-32	273	11½	6274	3·8	248·44	Hospital for Insane ...	Searchlight of Sunny Vale
Glanavon Miranda	do. ...	2365	6-5-30	8-9-32	273	16	5703	4·2	238·03	D. Bevan	Pine Creek Dunbar
Glanavon Phoebe	do. ...	5144	17-9-30	17-8-32	273	16	5508	4·2	234·39	A. E. Grant	Raleigh Regent
Yanget Pansy	do. ...	5154	4-9-30	14-8-32	273	13	4694	4·3	204·10	A. E. Grant	Tipperary Headlight
Woodendale Duchess	Jersey ...	...	7-4-30	10-6-32	240	11½	3480	5·4	195·30	F. P. Atwell	Mokine Lady's Chief
Greenmount Beauty	do. ...	...	10-10-30	30-6-32	240	10	3675	4·5	166·80	F. P. Atwell	Granthams Starbrights King
Yanget Milkmaid	A.I.S. ...	2445	29-4-30	28-7-32	210	12½	3680	4·4	163·31	A. E. Grant	Baron of Darbalara
Glanavon Vilma	do. ...	2370	18-7-30	30-9-32	210	15	4065	...	162·48	D. Bevan	Pine Creek Dunbar
Glanavon Anne	do. ...	2360	24-7-30	13-9-32	210	10½	3390	...	138·33	D. Bevan	do. do.
Brookvale Lady	Jersey ...	...	2-3-31	18-9-32	210	11½	2730	...	127·32	G. F. Combs	
Greenmount Bo-Peep's Fancy ...	do. ...	...	21-6-30	27-8-32	180	9	2625	4·8	126·42	F. P. Atwell	Werribee Starbright King

"CONTROL OF BLACK SPOT OR SCAB OF PEARS IN WESTERN AUSTRALIA."

Joan Hearman, B.Sc.

ADDENDUM.

In connection with the article under the above title, which appeared in the last issue of this Journal (June, 1933, pages 292-316), it is desired to call attention to the following details, which were unfortunately overlooked in the rush of preparing the manuscript for publication.

1. *Use of calcium caseinate spray spreader with all sprays.*—Calcium caseinate was used as a spreader at the rate of one pound (1 lb.) to every hundred gallons (100 galls.) of "Lime Sulphur" and "Bordeaux Mixture" used in the experiments.

2. *Details of costs of spray materials.*—The costs estimated in the table on page 305 headed "Cost of Spraying" were based on the following prices:—

Bluestone—37s. 6d. per cwt. (approx. 4d. per lb.).
Quicklime—2s. 9d. per 38 lb. tin (0.87d. per lb.).
Spreader—10d. per lb.
Lime Sulphur—1s. 10d. per gallon.

3. That part of the summary dealing with the *control of the disease* has been extended, and now reads as follows (*the additions being given in italics*):—

Control of the Disease.

(i) The disease was effectively controlled on a property where it had been unusually serious for some years prior to these experiments.

(ii) Ploughing-in of over-wintered leaves early in the Spring, *i.e.*, before the buds burst, was an important factor in the control of the disease.

(iii) *Where no spray was used and the ground was ploughed early, i.e., before the "bud-bursting" stage, a good crop matured but was so badly diseased as to be unmarketable.*

(iv). *Where no spray was used and the ground was not ploughed early, the crop became so badly diseased that it fell off before maturity.*

(v) Bordeaux Mixture was more effective on both varieties used in the experiments, *i.e.*, Glou Morceaux and Beurre Bosc, as a spray to control "Black Spot" of pears than Lime Sulphur, because it retained its protective qualities over a much longer period than did Lime Sulphur. *Calcium caseinate was used as a spreader in all sprays. No noticeable spray injury of any kind was caused to the fruit at any time.*

(vi) Four sprayings with Bordeaux Mixture applied at the "green-tip" (5:4:50), "pre-pink" to "pink," "petal-fall" and "10 days later" stages (all 3:4:50), *following early ploughing*, gave very good control of "Black Spot." (79 per cent. perfect Glou Morceaux fruit; 89.5 per cent. marketable.)

(vii) A spraying with Bordeaux Mixture (3:4:50) applied one month later improved the control (89 per cent. perfect Glou Morceaux fruit; 93 per cent. marketable).

(viii) One spraying with Bordeaux Mixture (5:4:50) in the early "pre-pink" stage had some effect in controlling the disease, even when the ground was not ploughed early.

(ix) A spraying in the previous autumn *with Bordeaux Mixture 6:4:50* or *Lime-Sulphur 1 to 15*, did not appear to contribute to the control of the disease in these experiments, in which the trees were heavily infected at the time of the application.

(x) The cost of material for four applications of Bordeaux Mixture was 3.56 pence per tree.

(xi) *The total crop carried by the trees in the experimental plots, with the exception of those mentioned in paragraph (iv), averaged seven (7) Australian bushel ("dump") cases per tree on the Beurre Boscs and three (3) Australian bushel cases per tree on the Glou Morceaux.*

The above amendments have been made in the reprinting of the article which has been issued as Leaflet No. 380 of the Department of Agriculture of W.A. Copies of the leaflet are obtainable free of charge on application to the Department.

A REVIEW.

THE INSECT BOOK.

We have received from the Shakespeare Head Press Ltd., of Sydney, an admirable little book on insects by Walter W. Frogatt, formerly Government Entomologist to the New South Wales Government. This is published in a handy size edition suitable for the student of entomology, containing a brief but lucid description of insects, and points out the damage done by those not included in the category of "friendly insects." There are numerous illustrations depicting the phases, life and habits of the insect world, and reference to this little volume should enable the easy identification of those which commonly meet the eye. While the work does not deal with eradication methods particularly, it does point out succinctly the form of damage caused by the character and habits of destructive insect pests.

THE TREE BOOK.

From the same publishers we have another similar work dealing with Trees, and entitled "The Tree Book". This is a compact edition by David G. Stead, and imparts to the reader a fund of information on the classification of Australian bushlands, explaining in a simple way the character and relationship of our native trees, tree zones, uses and nature of timbers, and also the beautification of the landscape. Each subject is dealt with in a brief chapter full of pith and clarity. To the student, the bush-lover and the traveller this work is highly commended.

Both these publications form part of a series of Nature books issued by the publishers, and are on sale at a retail price of 2s. each.

THE VALUE OF MANGANESE AS A FERTILISER IN WESTERN AUSTRALIA.

BY

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INTRODUCTORY.

Manganese and Plant Growth.

Scientific discoveries and progress in practice have always been supplementary, and it is often very difficult to evaluate the separate contributions of the scientific and practical outlook in any problem. Experience shows that progress is made possible by the observation of facts and the use of those facts, and deductions arising therefrom, in everyday problems. Observations on the effect of nitre on plant growth led to the establishment of an enormous industry in nitrogenous fertilisers. The invention of the microscope made possible the development of the science of bacteriology. Stimulation in research has always been obtained from the recognition of the needs of mankind and the desire to know nature better.

The knowledge of the importance of manganese in plant growth has developed from the observation by Scheele, in 1785, that the ash of the plant, "wild anise", contained manganese. Its practical significance was not realised until the beginning of this century when field and pot experiments demonstrated a response in crop growth to the use of manganese salts as fertilisers on certain soils. Although this stimulation in growth was observed in many places, particularly in France, Italy and Japan, the effect was far from general. Kelley (1912), reviewing the situation, concluded that the use of manganese salts as fertilisers could not generally be recommended. Since that time the position has been studied by scientists throughout the world and it is now known that manganese is a factor to be considered in crop production only under certain restricted conditions in most countries.

1. *Manganese as an injurious factor.*

Excess of manganese has been found to exert an injurious effect on pineapples in Oahu, Hawaiian Islands, causing chlorosis by immobilisation of iron (Johnson 1924). Bare patches in couch grass lawns, and failure of patches in barley crops have been correlated by Cohen (1910) and Guthrie and Cohen (1909) in New South Wales, with variations in soil manganese.

Used as a fertiliser, applications in excess of about 100 pounds per acre are liable to cause crop injury.

2. *Conditions favouring crop response to manganese as a fertiliser.*

While manganese does not appear to be lacking in availability in soils in most cases, conditions have been defined under which marked response is observed when used in small amounts as a fertiliser or spray.

*Assisted by R. G. Lapsley, B. L. Southern and F. W. Steel.

(a) *Alkalinity in soil reaction.*

Chlorosis of crops on heavily-limed soils is known as "lime-induced chlorosis" and has been observed in many parts of America. The condition is due to the rendering of the soil manganese unavailable by adjusting the soil reaction to a value between pH 7.0 and pH 9.0. Under these conditions a control is effected by the use of 28 to 56 pounds of manganese sulphate per acre as a fertiliser or by spraying with manganese sulphate in solution at the rate of 8 pounds per acre.

On some soils, naturally alkaline, certain diseases have been proved to be due to unavailability of manganese. "Roadside Take-all" of oats at Mt. Gambier, and failure of barley at Corny Point, South Australia, have been prevented by use of manganese sulphate as a fertiliser. Phenomenal increases in yield of tomatoes and truck crops have been obtained in the calcareous everglades in Florida by the use of small annual applications of manganese.

(b) *Oxidising conditions.*

Highly oxidising conditions depress manganese availability. Readily decomposable organic matter and water-logging tend to raise the availability of soil manganese. Thus, the use of manganese on the Florida everglades obviates the need for heavy applications of farm-yard manure. Water-logging increases water soluble and replaceable manganese and leads to increased absorption of that element by plants (Godden and Grimmett (1928)).

(c) *Soil poverty with respect to manganese.*

In some soils the manganese content is so low that response to its use as a fertiliser would be expected.

MANGANESE IN THE SOIL.

Manganese occurs in igneous rocks and the old recrystallised sediments (metamorphic schists) as a partial substitute for the iron of such ferruginous minerals as hornblende, pyroxene, biotite and chlorite, all of which are complex silicates. In limestones and dolomites it is present as manganese carbonate in combination with the carbonates of lime and magnesia. In recent sediments and in soils it is mostly present as psilomelane, a compound of manganese oxides, potash and water. Clarke (1924) page 34 estimates the composition of the earth's crust with respect to manganese as follows:—

Igneous rocks	..	0·096% manganese
Limestone rocks ..	..	0·040% manganese
Weighted average ..	..	0·091% manganese

This manganese is the source of that in soils. In soils, manganese generally occurs to the extent of a few hundredths of a per cent., the range being from a trace to 7 per cent. Figures showing the findings of various investigators are later compared with the results of this investigation. (Tables 5 and 6.)

Probably the most important fractions of the soil manganese, as far as the plant is concerned, are the water soluble fraction, and the fraction in the soil clay existing in the replaceable condition, *i.e.*, rendered soluble by treatment with solutions of neutral salts such as ammonium chloride or sodium chloride.

The replacable manganese usually varies from a trace to 0.06 per cent. manganese on the dry soil basis. Schollenberger and Dreibelbis (1930) found that 30 years of cropping reduced this fraction from 0.0245 per cent. to 0.0074 per cent. Liming was even more potent in reducing this fraction than cropping. Piper (1931), studying the effect of the addition of manganese sulphate on the soil, detected 20 per cent. of the added manganese in the replaceable form after 4 weeks, the remainder apparently reverting to the more inert oxidised state. Water-logging causes a chemical reduction of the more inert soil manganese and results in a substantial increase in replaceable manganese as well as water soluble manganese.

This condition is correlated with improved crop returns following temporary water-logging of soils deficient in available manganese. Piper's (1931) results are cited in Table.

TABLE 1.—EFFECT OF WATER-LOGGING SOILS DEFICIENT IN AVAILABLE MANGANESE ON YIELD OF OATS.

Soil.	Yield of Normal Soil.		Yield from Soil following Water logging for one week.	
	Gms. per Pot.	Per cent.	Gms. per Pot.	Percentage of Normal Soil.
Mt. Gambier	1·5	100	75·0	5,000
Penola	15·2	100	23·4	154
Corny Point	6·3	100	55·8	885

EXPERIMENTAL.

In view of the results observed in South Australia (reported by Samuel & Piper (1928) (1929) and Scott (1932)) two tons of manganese sulphate were made available for trial in Western Australia in 1931. Experiments were arranged throughout the agricultural areas on State Experiment Farms and on private farms.

Already Carne (1927) had reported the finding of the "Grey Speck Disease" at Dwarda and the disease had been observed in various parts of the southern portion of the wheat belt, generally in association with powdery soils of mallet (Eucalyptus astringens) hills. In this investigation experiments were arranged on a wide variety of soils, particular attention being paid to highly calcareous types. Crops tested included wheat, oats, and pasture, and representative soils were examined chemically for manganese content.

The accompanying map shows the isohyets, railways, and principal towns and districts of the Agricultural portion of the State in addition to the centres at which experiments were conducted.

THE SOILS INVESTIGATED.

The soils investigated fall into the following groups:—

(A) Soils of the mallee zone of the wheat belt associated principally with Salmon gum (E. salmonophloia), gimlet (E. salubris) and morrel (E. longicornis) timber.

(B) Brown earth soils of the jam (Acacia acuminata) and York gum (E. fœcunda var. loxophleba) belt.

(C) Soils of the clover belt in the high rainfall area of the South-West characterised by timber including jarrah (E. marginata), marri or red gum (E. calophylla) and karri (E. diversicolor).

(D) Sandy lateritic scrub plain soils represented by the Wongan Hills Light Land Experiment Farm.

(E) Powdery soil carrying mallet (E. astringens) from Dwarda.

CHEMICAL AND PHYSICAL PROPERTIES OF THE SOILS.*

The chemical and physical characteristics of representatives of the various soils studied in these groups are summarised in Tables 2, 3 and 4. Further information concerning the salmon gum and gimlet loam of Merredin is given by Prescott (1931) and Sutton (1920). In the latter paper analyses of jam soils from the Chapman Experiment Farm are also cited.

*Chemical work executed in the Government Chemical Laboratory by A. J. Hoare and Associates.

TABLE 2.—CHEMICAL, PHYSICAL, AND OTHER CHARACTERISTICS OF SOILS OF THE MALLEE GROUP.

District.	Farmer.	Rainfall f 1 1.	Soil Profile.	Characteristic Timber.	Chemical properties 0—9" layer (percentage dry soil).			
					Water Soluble Salts (average).	pH.*	$CaCO_3$.	Manganese Soluble in Concen. HCl.
		inches.			per cent.		per cent.	percentage Mn.
Merredin	Experiment Farm...	12·25	Red brown loam on calcareous clay	Salmon gum, gimlet...	0·076	8·31	0·227	0·031 ± ·0105*
Southern Cross ...	Experiment Farm ...	10·19	do. do. do.	do. do. ...	...	...	....	0·022 ± ·0036*
Nungarin	Johnson	12·72	do. do. do.	do. do. ...	...	...	...	0·029
Lake Carmody ...	Boulton	14·88	Brown loam on calcareous clay	Gimlet and merrit ...	...	...	...	...
Lake Biddy ...	Sandells	11·71	Calcareous sandy loam ...	Salmon gum, morrel...	...	...	3·70	0·016
Lake Grace ...	McMahon	14·59	Grey calcareous loam	Kondinin blackbutt ...	...	...	...	0·025
					NaCl (%)—			
Lake Varley ...	Abernethy 4A ...	...	Grey brown calcareous sandy loam	Morrel	0·061	...	2·88	0·017
Do. ...	Abernethy 4B ...	...	do. do. do.	do.	0·102	...	4·91	0·037
Do. ...	Abernethy 4BA ...	...	do. do. do. ...	do.	0·057	...	5·14	0·016
Lake Brown ...	Meston	9·41	do. do. do. ...	do.	...	...	...	...
Do. ...	Mulqueeny ...	9·41	do. do. do. ...	do.	...	...	4·40	0·0648
Nungarin	Herbert	12·72	do. do. do. ...	do.	...	...	...	...
					Water sol.salts (%)—			
Salmon Gums ...	Experiment Farm ...	16·69	Light brown sand on calcareous clay	Mallee scrub	0·200	8·14	2·14	0·0052 ± ·0031*
Scaddan	Grigg	20·53	Heavy clay	do.	...	...	...	...
Dampawah ...	Experiment Farm ...	11·87	Red loamy sand	York gum, yorrel, etc.	...	...	...	...
							Average ...	0·026

*Standard error calculated from $\sqrt{\frac{\Sigma d^2}{n-1}}$

* pH. determined on 1—1 suspension, by Quinhydrone method.

TABLE 3.—CHEMICAL, PHYSICAL, AND OTHER CHARACTERISTICS OF SOILS OF THE JAM, YORKGUM GROUP.

District	Farmer.	Rainfall for 1931.	Soil Profile.	Vegetation.	Chemical Properties 0—9″ layer (percentage dry soil).	
					pH.*	Manganese Soluble in Conc. HCl.
		inches.				percentage Mn.
Nabawa	Chapman Experiment Farm ...	20·09	Brown loamy sand on clay	Jam, wattle, and york gum ...	7·32	0·0275
Beverley	Avondale Experiment Farm ...	18·51	Brown loam on clay	York gum, jam...	...	...
Muresk	Agricultural College	18·14	Brown loam on clay	York gum, jam...	...	...
Southern Brook ...	Bostock	14·48	Loam on clay	Salmon gum	...	0·017*
Do. ...	do.	14·48	Sand	Jam and scrub	...	0·0036*

* to 20 inches deep.

TABLE 4.—CHEMICAL, PHYSICAL, AND OTHER CHARACTERISTICS OF SOILS OF OTHER GROUPS.

District.	Farmer.	Rainfall for 1931.	Soil Profile.	Vegetation	Chemical Properties (percentage dry soil.)				
					Water Soluble Salts (average).	pH.*		Manganese Soluble in Concen. HCl.	
						0-9″	9-18″	0-9″	9-18″
		inches.			per cent.			percentage Mn.	
Busselton ...	State Farm (Sabina Vale)	32·59	Sandy loam	Red gum, blue gum, banksia ...	...	6·35	5·72	0·022	0·023
Do.	do. do. ...	32·59	Heavy soil	do. do. do. ...	...	4·30	4·30	0·0006	0·001
Northcliffe ...	Bennett (loc. 9011) ...	59·37	do.	Karri, red gum, casuarina	...	7·08	6·31	0·016	0·083
Do. ...	Thompson (loc. 10282) ...	59·37	Grey sand	Bottle brush, blackboy	...	6·49	6·52	0·077	0·061
Dwarda	O'Connell	29·27	Powdery calcareous loam	Mallet	...	6·48		0·018*	
Wongan Hills ...	Experiment Farm ...	12·91	Grey sand on gravelly clay	Low scrub	0·078	6·02		0·0011†	

* Precipitation as Mn_3O_4. † Average of determinations on 15 separate samples.

* pH. determined on 1—1 suspension, by Quinhydrone method.

It is seen that the range is from calcareous loams of the wheat belt to acid soils of the clover belt. The content of manganese soluble in concentrated hydrochloric acid varies from a *bare trace* to 0.077 per cent. of the dry soil.

To complete the picture, these results, together with figures from analyses of Western Australian soils in connection with other projects, are compared with analyses reported from other parts of the world in Table 5. A comparison of the water soluble and replaceable manganese content of soils from various parts of the world is made in Table 6.

TABLE 5.—COMPARISON OF MANGANESE CONTENT OF SOILS IN WESTERN AUSTRALIA WITH SOILS OF OTHER PARTS OF THE WORLD.

Worker.	Country or District.	No. of Samples Analysed.	Soil Manganese (percent. Mn dry soil).	
			Total Manganese (fusion).	Manganese Soluble in conc. HCl.
FOREIGN—			per cent.	per cent.
Sullivan & Robinson (1912)	United States of America ...	26 (averaged)...	0·055	...
Robinson (1929) ...	United States of America and Philippines	57 ,, ...	0·290	...
Robinson & Holmes (1924)	United States of America ...	34 ,, ...	0·0952 (0·0008– 0·496)	...
Emmert (1931) ...	Kentucky	5 ,, ...	0·226 (0·045– 0·420)	...
McGeorge (1929) ...	Hawaiian Islands	20 ,, ...	...	0·079
Do.	do.	1 ,, ...	...	3·26
EASTERN STATES OF AUSTRALIA—				
Piper (1931) ...	South Australia (Mt. Gambier)	...	...	0·032
	(Penola) ...	...	...	0·005
	(Corny Point)	...	...	0·019 0-9″ layer
WESTERN AUSTRALIA—				
The Authors ...	Salmon gum, morrel and mallee soils	73 (averaged)...	...	0·023
	Jam and york gum soils ...	2 ,, ...	0·0302	0·026
	Clover belt soil (high rainfall)	4 ,, ...	...	0·029
	Mallet soils—Dwarda (1931)	4 ,, ...	...	0·018
	Scrub plain soils—Wongan Hills	15 ,, ...	...	0·0011 (nil to 0·0027)
	Merredin Experiment Farm	15 (composited)	0·0302	0·0275
	Abernethy's morrel country	12 ,, ...	0·0410	0·0356
	Mulqueeny's morrel country	4 ,, ...	0·0734	0·0648
	Sandell's morrel country ...	4 ,, ...	0·0184	0·0186
	Chapman Experiment Farm	15 ,, ...	0·0302	0·0275
	Wongan Hills Experiment Farm	15 ,, ...	0·0032	0·0032
Government Chemical Laboratory	Mallet soils—Dwarda (1926)	3 (averaged)...	...	0·018
Do. ...	Denmark (1928)	3 ,, ...	...	0·038 (0·018 to 0·054)
				0–6″ 0·006
Do. ...	Salmon Gums Experiment Farm (1929)	1 (Serial No. 49)	...	6–24″ 0·007
				24–28″ 0·007
Do. ...	Lake King (morrel type) ...	1 (Surface and subsoil averaged)	...	0·026

TABLE 6.—WATER SOLUBLE AND REPLACEABLE MANGANESE IN SOILS AND THE EFFECT OF WATER-LOGGING, LIMING, CULTIVATION, ETC., ON THESE FRACTIONS.

Worker.	Soil.	Treatment.	pH.	Water Soluble Manganese. Manganese(Mn) in Dry Soil.	Replaceable Manganese. Manganese (Mn) in Dry Soil.
				p.p.m.	p.p.m.
UNITED STATES OF AMERICA—					
Metzger (1931) ...	Clarkville silt loam	Air dry	...	...	318
	do. do.	Flooded	...	...	426
	Crawley rice soil surface	Virgin	...	...	305
		Irrigated	...	...	331
	Crawley rice soil subsoil	Virgin	...	...	26
		Irrigated	...	...	262
Schollenberger and Dreibelbis (1930)	Wooster silt loam	Virgin	Acid	...	245
		Cultivated 30 years ...	,,	...	74
		Cultivated + lime ...	,,	...	11
Schollenberger (1928)	Wooster silt loam	Untreated	,,	...	55
		Water-logged	,,	...	440
		Water-logged + starch	,,	...	580
EASTERN STATES OF AUSTRALIA—					
Piper (1931) ...	Mt. Gambier ...	Untreated	8·07	Trace	4·2
		Water-logged	...	1·9	...
		Water-logged + dextrose	...	5·45	...
		Water-logged + aeration	...	0·05	...
	Penola	Untreated	6·9	Trace	...
		Water-logged	...	0·08	...
		Water-logged + dextrose	...	0·32	...
	Glen Osmond ...	Untreated	7·4	Trace	65·7
		Water-logged	...	6·3	...
		Water-logged + dextrose	...	13·0	...
		Water-logged + aeration	...	3·0	...
WESTERN AUSTRALIA—			*		
The Authors ...	Merredin Experiment Farm	Normal	7·82	3·2	111
		Waterlogged	7·43	15	139
	Abernethy's morrel country	Normal	8·01	4·3	23
		Waterlogged	7·58	14	46
	Mulqueeny's morrel country	Normal	8·08	5·4	70
		Waterlogged	7·61	8·6	128
	Sandell's morrel country	Normal	7·70	3·2	26
		Waterlogged	7·48	7·6	37
	Chapman Experiment Farm ...	Normal	7·02	5·4	156
		Waterlogged	7·02	41	203
	Wongan Hills Experiment Farm	Normal	6·10	2·2	13
		Waterlogged	6·97	8·6	19

* pH. determined on 1—1 suspension, by Quinhydrone method.

On the average the Australian soils investigated are lower in total and replaceable manganese than soils of the United States of America, the Hawaiian Islands and the Philippine Islands. There does not appear to be any serious general deficiency, however, except in such soils as the sandy lateritic scrub plain soils represented by the Wongan Hills Experiment Farm and, perhaps, swamp soils of the type represented at Penola, South Australia. The magnitude of the water soluble and replaceable fractions indicates that the general condition of the manganese with respect to availability appears to be normal. Furthermore, short periods of water-logging, in this case, one week, lead to significant increases both in water soluble and replaceable manganese. As suggested by Piper (1930), this behaviour may be quite important agriculturally, for such soils as the calcareous morrel soils, being relatively rich in organic matter, may thus respond sufficiently to the winter

rains to provide the available manganese necessary for crop growth. The behaviour of the mallet soils at Dwarda points in the same direction. In these experiments the response to manganese fertiliser (Table 9) occurred only in the cold winter months. With the advent of moist and warm spring weather the control plants recovered from the symptoms of manganese deficiency and made growth equal to that on the plots treated with manganese sulphate. The availability of the low percentage (0.018) of manganese in this soil is apparently adequate for the growth of wheat or oats under favourable climatic conditions.

Of particular interest is the lateritic soil from Wongan Hills, which shows an abnormally low manganese content. Of the fifteen samples analysed to represent this soil, six showed no visible reaction for hydrochloric acid soluble manganese and the highest figure recorded was 0.0027 per cent., approximately one-tenth the average figure for the Western Australian soils examined. The content of replaceable manganese, determined on the composited sample, was only 13 p.p.m., and this fraction was raised only to 19 p.p.m. by water-logging.

This response is much lower than normal and suggests a low availability of the manganese as well as a poverty with respect to absolute amounts. It is of significance that these chemical data should be correlated with a significant, if small, response to manganese as a fertiliser.

The analysis of the soil from the Chapman Experiment Farm shows a concentration of 41 p.p.m. water soluble manganese in the water-logged sample. As these soils are very subject to water-logging in winter, there is a possibility of manganese injury being experienced during this period. This affords an additional argument in favour of farm drainage is those districts suffering from excess winter rains.

THE FIELD EXPERIMENTS.

A. *Experiments on private farms with wheat.*

These experiments were arranged particularly to afford data concerning the effect of manganese sulphate on calcareous soils of the Eastern wheat belt, which had carried morrel (E. longicornis) in the virgin state. This type of soil is rich in plant requirements, but is of poor physical condition, being very powdery when dry, and is high in calcium carbonate even in the surface horizon, resembling, in these respects, the manganese-deficient soils of Corny Point, South Australia. While it is generally regarded as unsatisfactory wheat land except under conditions of very favourable rainfall, it will carry a heavy growth of such forage as barley grass (Hordeum murinum). With proper farm management, involving stock husbandry and shallow cultivation to effect consolidation, certain types of morrel country produce quite good crops of wheat even under the low rainfall conditions of the Eastern wheat belt. It was felt that these soil conditions would favour a positive response to manganese fertilisation.

To control the experiments on morrel country, and also the rather similar blackbutt (E. Kondininensis) country, collateral experiments were organised on typical salmon gum, gimlet and mallee soils. In these soils the profile is normal, showing a non-calcareous surface loam (A horizon) with a good subsoil rich in clay and calcium carbonate. The general properties of the soils of these plots are tabulated in Tables 2, 3 and 4 above.

The experiments were arranged on fallowed land (with one exception) and the plots were laid out and the seeding supervised by technical officers of the Department of Agriculture. Conditions of planting conformed as nearly as possibly to the best practice of the wheat belt with respect to wheat variety, time of seeding, preparation of the seed bed and fertiliser treatment. Generally four one-quarter acre plots, separated by buffer plots to facilitate harvesting, were pegged and sown as follows:—

1. *Control*: Plots 1 and 3: seed and 112 lbs. of 22 per cent. superphosphate per acre.

2. *Manganese treatments*: Plots 2 and 4: seed and 112 lbs. of 22 per cent. superphosphate plus 56 lbs. of manganese sulphate per acre.

Owing to a hitch in the arrangements, on the farms of Messrs. Meston and Mulqueeny, of Lake Brown, the manganese sulphate was used as a top dressing on July 3rd and July 1st respectively instead of being applied with the seed at planting in May. Mr. Mulqueeny's plots were on unfallowed stubble land.

The results of the thirteen experiments with wheat on ten farms are reported in Table 7.

TABLE 7.—THE EFFECT OF MANGANESE SULPHATE AS A FERTILISER ON THE YIELD OF WHEAT IN TRIALS CONDUCTED ON PRIVATE FARMS, 1931.

All Plots received 22 per cent. Superphosphate at approximately 112 lb. per acre. Manganese Sulphate was applied at the rate of 56 lbs. per acre.

District.	Farmer.	Principal Native Vegetation.	Superphosphate and Manganese.			Superphosphate—Control.		
			Plot 2.	Plot 4.	Average Yield as per cent. of Control.	Plot 1.	Plot 3.	Average Yield as 100 per cent.
Southern Brook	Bostock ..	Salmon gum ...	Yields reported to be the same by Group Settlement Department.					
Do. ...	do. ...	Jam and scrub	Yields reported to be the same by Group Settlements Department.					
			bus. lb.	bus. lb.	%	bus. lb.	bus. lb.	%
Lake Varley ...	J. Abernethy ...	Morrel (4A) ...	7 17	5 45	88	9 24	5 22	100
Do. ...	do. ...	Morrel (4B) ...	5 56	8 34	123	5 22	6 26	100
Do. ...	do. ...	Morrel (4BA)...	19 0	21 3	105	18 26	19 22	100
Lake Brown ...	Meston 1 ...	Morrel ...	9 20	12 32	92	10 56	12 52	100
Do. ...	Mulqueeny 2 ...	do. ...	9 52	10 16	101	9 28	10 28	100
Nungarin ...	G. Herbert ...	do. ...	18 24	17 16	96	19 18	17 48	100
Lake Grace ...	McMahon ...	Blackbutt ...	14 24	15 4	100	14 40	14 44	100
Lake Biddy ...	Sandells ...	Salmon gum and morrel	10 36	7 20	96	10 4	8 32	100
Nungarin ...	Johnson ...	Salmon gum ...	22 24	22 58	103	21 40	22 20	100
Lake Carmody	Boulton ...	Gimlet and Merritt	32 4	30 48	100	32 20	30 20	100
Scaddan ...	Grigg Bros. ...	Mallee scrub ...	15 44	16 0	104	15 28	15 4	100
	Average percentage Yield ...		...	...	101	...	...	100

The maximum positive effect observed was 23 per cent.; the maximum negative effect, 12 per cent., both from the same paddock on morrel soil (Abernethy, Lake Varley). These differences are undoubtedly attributable to soil variability and are deemed not significant.

It is concluded that treatment with manganese sulphate as a fertiliser is ineffective under the conditions of these experiments.

The average percentage yield *with* manganese sulphate is 101 as compared with the controls reckoned at 100. Considering the experiments on morrel and blackbutt soils alone, the average yields of the controls and the treated plots are practically identical.

Additional interest is attached to the three sets of experiments on Mr. J. Abernethy's farm at Lake Varley. Each set was arranged on morrel and boree country in the same paddock to ascertain the effect of manganese sulphate on soils variously affected with alkali or excess of water soluble salts. All plots were on new land fallowed. The set of plots designated 4B were on powdery, highly calcareous soil, which was badly affected with alkali. Those designated 4BA were on very similar soil physically, but relatively free of alkali. Plots designated 4A were on soils somewhat more sandy, less powdery, lower in calcium carbonate in the surface, and also relatively free of alkali as compared with those designated 4B.

The striking difference in yield between plots 4B and 4BA is correlated with the occurrence of soil alkali, and it is apparent that manganese sulphate as a fertiliser had little effect on the tolerance of wheat for soil alkali. No explanation of the low yields on plots 4A can be offered.

B. *Experiments on the State Experiment Farms.*

On the seven Experiment Farms of the wheat belt and at the Muresk Agricultural College more critical experiments were conducted, using the usual methods employed by the Department of Agriculture on the State Experiment Farms. A wide and representative range of climatic conditions and soil types occur in this list and the results supplement the experiments on the private farms in the wheat belt. The general properties of the various soils represented by these farms are tabulated, with others, in Tables 2, 3, and 4 above.

Fertiliser treatments used in this experiment on each farm were—

1. 112 lbs. of superphosphate per acre.—*Control.*
2. 112 lbs. of superphosphate plus 28 lbs. of manganese sulphate per acre.
3. 112 lbs. of superphosphate plus 56 lbs. of manganese sulphate per acre.

Each treatment was replicated five times and the plots were arranged on the three plot system. Each plot was one-eighth of an acre in area.

The details of the results from the Experiment Farms are reported by Thomas and Langfield (1932) for the Merredin Experiment Farm, Thomas and Shier (1932) for the Chapman Experiment Farm, Thomas and Prunster (1932) for the Yilgarn Experiment Farm, Thomas and Venton (1932) for the Wongan Hills Light Lands Farm, Thomas and Seinor (1932) for the Salmon Gums Experiment Farm, Wild and Bailey (1932) for the Avondale Experiment Farm, and by Hughes and Riches (1932) for the Muresk Agricultural College.

TABLE 8.—SHOWING THE YIELD OF WHEAT AND OATS AS AFFECTED BY APPLICATION OF MANGANESE SULPHATE AS A FERTILISER IN ADDITION TO SUPERPHOSPHATE, ON THE EXPERIMENT FARMS, WESTERN AUSTRALIA, 1931.

Each Yield is the Average of the Yields from the Five Plots under each Treatment

Farm.	Seed.		Fertiliser.		Wheat Yield per Acre.				Chance of difference from Control being due to Manganese Treatment.	Statistical Significance of Differences.
	Variety.	Rate. (lbs. per acre.)	Superphosphate. (lbs. per acre.)	Manganese Sulphate. (lbs. per acre.)	Bus.	Lbs.	Standard Error of Mean Difference lbs.	Per cent.		
Merredin	Gluyas Early Wheat	45	112	Nil	21	28	± 28·6	100		
		45	112	28	21	52	...	102	60 per 100 ...	Not significant.
		45	112	56	21	31	...	100	20 per 100	
Chapman	Nabawa Wheat ...	60	112	Nil	20	37	14·3	100	... ...	Significance very doubtful.
		60	112	28	21	9	...	103	97·5 per 100	
		60	112	56	21	7	...	103	96·4 per 100	
Wongan Hills ...	Nabawa Wheat ...	45	135	Nil	16	22	21·6	100	Control	Significant.
		45	135	26	17	47	...	109	99·9 per 100	
		45	135	52	17	49	...	109	99·994 per 100	
Yilgarn	Noongaar Wheat ...	30	95	Nil	17	12	27·9	100	Control	Significance doubtful.
		30	95	26	18	32	...	108	99·4 per 100	
		30	95	52	17	54	...	104	83·8 per 100	
Salmon Gums ...	Gluyas Early Wheat	45	112	Nil	13	31	30·3	100	Control	Not significant.
		45	112	28	12	53	...	95	79 per 100	
		45	112	56	12	29	...	92	96 per 100	
Dampawah ...	Gluyas Early Wheat	45	112	Nil	11	20	12·0	100	Control	Significance doubtful.
		45	112	28	11	18	...	100	10 per 100	
		45	112	56	11	57	...	105	99·8 per 100	
Avondale	Nabawah Wheat ...	60	112	Nil	15	52	38·6	100	Control	Not significant.
		60	112	28	15	20	...	97	60 per 100	
		60	112	56	15	2	...	95	79 per 100	
Muresk	Nabawah Wheat ...	60	112	Nil	21	58	57·7	100	Control	Not significant.
		60	112	28	22	48	...	104	61 per 100	
		60	112	56	22	48	...	104	61 per 100	
Muresk	Mulga Oats ...	60	112	Nil	53	8	14·8	100	Control	Not significant.
		60	112	28	52	37	...	99	6 per 100	
		60	112	56	48	6	...	90	82 per 100	

The results, treated statistically according to the method of Engledow and Yule (1926), are summarised in Table 8.

From this summary it is apparent that only at the Wongan Hills Light Lands Farm, has manganese sulphate had a statistically significant effect on the yield of wheat. There the average increase in yield was one bushel twenty-six pounds of wheat per acre or nine per cent. of the yield of the control plots. The increases in the average yields, observed at Chapman, Yilgarn, and Dampawah, are of very doubtful significance.

It is striking that the only definitely significant result has been observed on the slightly acid sandy surfaced, lateritic soil of Wongan Hills, which is practically virgin, having been cropped only once previously. This observation is correlated with an extremely low content of hydrochloric acid soluble, total and replaceable manganese. The average content of concentrated hydrochloric acid soluble manganese of the 15 samples from the Wongan Hills plots was 0.0011 per cent. Mn. Six of the samples gave no visible test for manganese and the highest figure obtained was only 0.0027 per cent. in the surface 9 inches of soil. Furthermore, the water-logging of this soil had but small effect on the normally low fraction of replaceable manganese. This poverty in manganese, undoubtedly a reflection of the history of this lateritic soil, may result in reduced crop growth, particularly in patches of exceptional deficiency, and thus be correlated with a positive response to manganese sulphate as a fertiliser. It will be of great interest to study the response to manganese after a considerable period of cultivation and cropping of this interesting soil type.

C. *The experiments in the clover and pasture belt.*

Certain observational trials were conducted in the higher rainfall areas, by the Dairy Branch of the Department of Agriculture and the Group Settlements Department, to determine the effect of manganese sulphate on pasture and hay crops. The results have been obtained from Department files and acknowledgment is made to the officers concerned for the information made available.

The reports of the officers observing the treatments are summarised in Table 9.

TABLE 9.—OBSERVED RESULTS OF THE EFFECT OF MANGANESE SULPHATE AS A FERTILISER SUPPLEMENTING SUPERPHOSPHATE FOR PASTURE.

Farm.	District.	Soil Texture.	Native Vegetation.	Crop.	Observed Effect of Manganese.
5416	Group 113 Denmark	Coarse sand	Sheoak, banksia, jarrah, bottlebrush	Pasture ...	None discernible.
2468	do. ...	Sand ...	Bottlebrush, teatree	do. ...	do.
Denmark Stud Farm	Denmark ...	Sandy loam	Karri ...	Oats, barley and pasture	do.
Clifton ...	Australind ...	do. ...	Tuart and peppermint	... ...	do.
	Group 136, Busselton	Red sand ...	... ...	Pasture ...	do.
O'Connell ...	Dwarda ...	Powdery calcareous loam	Mallet (E. astringens), etc.	Oats ...	No difference in yield. Manganese produced healthier appearance early in season.
Bennett (Loc. 9911)	Group 100, Northcliffe	Heavy soil ...	Karri, red gum, casuarina	Oats and pasture	None discernible.
Thompson (Loc. 10280)	Group 128, Northcliffe	Grey sand ...	Blackboy, bottlebrush	Oats and pasture	do.
Sabina Vale State Farm	Busselton ...	Sandy loam	Red gum, blue gum, banksia	do.	Early growth of oats appeared superior: grain yield and pasture growth showed no difference at harvest.
Do. ...	do. ...	Heavy soil ...	do do.	do. ...	do. do.

No observable response to the use of manganese sulphate in addition to superphosphate was noted in any case. The response early in the season at Dwarda, on soils shown to be deficient in available manganese by Carne (1927) and liable to the "Grey Speck Disease", did not persist after the cold winter months had expired.

SUMMARY AND CONCLUSIONS.

A study of the extensive literature on manganese in relation to crop growth has shown that, under certain circumstances, crops respond to dressings of soluble manganese salts as fertilisers and sprays, owing to the *unavailability* of this essential element in the soil.

The factors contributing to unavailability of soil manganese include—

1. A neutral or alkaline soil reaction, particularly following heavy dressings of lime.
2. A high state of oxidation of the soil manganese.
3. Actual dearth of manganese in the soil.

In view of phenomenal responses of crops (particularly oats and barley) to dressings of manganese sulphate on certain soils at Mt. Gambier, Penola and Yorke's Peninsula in South Australia, a comprehensive set of experiments with this salt was arranged in Western Australia in 1931. It was desired to ascertain the effect of manganese sulphate under a wide range of representative soil and climatic conditions.

Particular attention was given to the alkaline and calcareous soils of the wheat belt. In connection with the field experiments arranged, soil samples were collected and examined in order to afford data concerning the manganese contents of Western Australian soils.

It was found that the Western Australian soils studied are all relatively low with respect to manganese soluble in hydrochloric acid. The mallee, jam, and scrub and lateritic soil types appear to be lowest in this element.

Chemical investigations showed that the manganese in the soils studied responded normally, chemically, to the treatments to which they were submitted, and that, except in the case of the lateritic soil from Wongan Hills, the soils were not significantly deficient in manganese.

With wheat, pasture and hay crops there appeared no signficant response in growth to manganese sulphate when used as a fertiliser at the rates of 28 and 56 pounds per acre under field conditions, except in the case of the lateritic soil from Wongan Hills.

A statistically significant increase in wheat yield of one bushel 26 lbs. per acre was observed at Wongan Hills on these acid lateritic soils which proved to be of exceptionally low manganese content. This increase, with a value of about 4s. 6d. with wheat at 3s. per bushel, cost 6s. with manganese sulphate at £24 per ton.

It is proposed that the response on this soil is due to an actual lack of manganese, particularly in patches, rather than to the unavailibility of the manganese present in the soil as it is correlated with a very low content of manganese soluble in concentrated hydrochloric acid, and a replaceable manganese fraction which is but little affected by water-logging.

From these experiments it may be concluded that it is unlikely that manganese fertilisers will materially increase crop yields on the major types of agricultural soils of the wheat belt and clover belt of Western Australia.* After some considerable period of cropping certain of the lateritic soil types may show some response to manganese fertilisers owing to extreme poverty with respect to this element.

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MAP
OF
THE SOUTHERN PORTION
OF
WESTERN AUSTRALIA
SHOWING
LOCATION OF MANGANESE EXPERIMENTS
TOGETHER WITH
ISOHYETS, RAILWAYS AND PRINCIPAL TOWNS

Location of Manganese Experiments shown thus ✲DWARDA

SCALE OF MILES
120 60 0 50 100

115° 117° 119° 121°
26° 28° 30° 32° 34°

MIANA
MULLEWA
YALGOO
UNA
NARAWA
GERALDTON
DAMPERWAH
LEONORA
KALANNIE
BONNIE ROCK
MILING
WONGAN HILLS
LAKE BROWN
SOUTHERN CROSS
KALGOORLIE
COOLGARDIE
NUNGARIN
SOUTHERN BROOK
MERREDIN
NORTHAM
PERTH
MUKINBUDIN
BEVERLEY
FREMANTLE
HYDEN
LAKE CARMODY
LAKE VARLEY
DWARDA
TINKURRIN
LAKE BIDDY
NEWDEGATE
SALMON GUMS
AUSTRALIND
LAKE GRACE
SCADDAN
BUSSELTON
PINGRUP
RAVENSTHORPE
ESPERANCE
MANNUP
DAILAC
NORTHCLIFFE
NORNALUP
WALPOLE
DENMARK
ALBANY

THE COST OF FEEDING PURE-BRED COWS UNDER THE OFFICIAL HERD RECORDING SCHEME, WESTERN AUSTRALIA, 1932-33.

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and
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During the present period of low prices, dairy farmers are much concerned with the costs entailed in producing milk and butter fat. For this reason the estimated cost of feeding pure-bred cows under official test during the past year should prove of particular interest. For a number of years tables have been published annually showing the productivity of the average tested cow, and the cost of the feed utilised to obtain this production. In Table I. the yearly averages are listed, and some interesting comparisons may be made.

Table 1.—PURE-BRED COWS UNDER OFFICIAL TEST.

Average Results for last Ten Years.

Year ending 30th June :	Average Milk Yield per Cow.	Average Butter Fat per Cow.	Average Cost of Feed per Cow.	Average Feed Cost to Produce 1 lb. of Butter Fat.	Average Feed Cost to Produce 1 Gallon Milk.	Average Value of Butter Fat per lb.
	gals.	lbs.	£ s. d.	pence.	pence.	pence.
1924	600	319·50	10 4 10	7·7	4·09	19·5
1925	652	308·59	14 13 2	10·77	6·15	17·5
1926	624	312·01	14 14 7	11·15	5·66	19·0
1927	602	290·72	14 10 5	12·00	5·79	19·0
1928	592	280·56	15 11 4	13·34	6·34	19·5
1929	629	295·10	15 1 0	12·24	5·74	20·0
1930	636	294·98	14 10 3	12·74	5·10	19·5
1931	643	301·6	9 14 7	7·74	3·64	16·0
1932	696	318·96	10 18 3	8·21	3·76	14·0
1933	664	308·6	9 2 3	7·08	3·29	11·0

It will be noticed that the average production is not quite so high as it was in 1931-32. This, however, does not signify retrogression as the fall of production is in part the result of the somewhat unfavourable season and also to the entry of new herds which have not such a high average production as those herds which have been tested for a number of years.

Of more significance is the fact that the cost of feed per cow per annum for 1932-33 is the lowest yet recorded, being £1 16s. cheaper than that of last year and almost £6 below the cost for 1928-29. Unfortunately the value of butter fat has shown a corresponding decrease, the average price for 1932-33 being only a little over half that received in 1928-29. Even so, a study of the tables given hereafter will show that many herds are still producing at a profit. It is only too apparent, however, that other herds cannot be doing this, as the cost of feed alone absorbs nearly all the income from sale. This illustrates how fundamental is the need for economic feeding methods.

That improved methods are being used is shown by the lowered average feed cost this year—the saving of £1 16s. per cow has been made despite a slight increase in the average cost of the foodstuffs commonly purchased by dairymen. This indicates an increased use of good pasture, meadow hay, silage and home-grown concentrates. In two herds the food to produce one pound of butter fat costs approximately 4d., while in two other herds the food to produce the same product costs over 11d. This great difference explains why the method of feeding is one of the chief factors in determining whether or not a dairyman is successful financially.

Of the 21 herds under review, herds "F" and "M" (see Table IV.) stand out as producers at a low cost. Both are of the Jersey breed and belong to Mr. P. Rose, Burekup, and Mr. G. F. Combs, Jardee, respectively. In both herds milk was produced at a food cost of less than 2d. per gallon.

The herd of Mr. P. Rose is one of the largest under official test, and good mixed pasture constitutes the main food supply. Very little concentrate (crushed wheat) is fed in the bails, and the high average yield of 348 lb. butter fat testifies to the value of good grazing. No green summer pasture is available, so—except for early maize—dependence is placed on meadow hay and silage for the summer months. This independence from purchased foodstuffs enables butter fat to be produced very cheaply. However, it is possible that the more lavish use of concentrates in this herd may have proved profitable, especially in prolonging the period of lactation.

Banyule Silvermine 55th (25473).
Owned by Sabina Vale Stud Farm, Wonnerup.
Highest producing cow in the Junior Three-year-old Class, standard 270 lbs. butter fat. Produced 7,726 lbs. milk, average test 5.65%, 435.66 lbs. butter fat.

Herd "M," owned by Mr. Combs, is maintained at the very low annual cost of £5 per head. The system of management appears similar to that of Mr. Rose. Very little purchased material is used, and large quantities of silage are conserved. As the test cows in this herd milked all through the summer, the average production of 294 lb. butter fat was quite good. Here, again, one cannot help but wonder whether or not increased use of concentrates would have been profitable. These cows could hardly have been producing to a maximum on bulky roughages.

Farmers tend to overlook the fact that 3½d. worth of concentrates (say 5 lb. of bran) contain sufficient nutrients to produce a gallon of milk worth at least 6d. (if 5% test). In other words, 20s. spent on bran or its equivalent, and used by the cow for production, would furnish sufficient nutrients to produce 32s. worth of butter fat at 11d. per lb. In this case the outlay would be very profitable. Of course, this would apply only where the cows already were

receiving ample cheap roughage in the paddock, and one must assume that the cows had the inherent ability to utilise the extra food supplied. Concentrates are often wasted because they are merely used by the cow to save it from foraging in the field. Good food stimulates a good cow, while it only encourages a natural low producer to loaf.

The third lowest cost of producing butter fat was recorded by Mr. S. P. Herbert at Nungarin. This is quite a creditable performance, as wheat belt herds generally have high feeding costs. Mr. Herbert's cows were probably more profitable than the figures indicate, as it is doubtful if the foodstuffs used (all home grown) were worth to him the value given them in working out the costs (see Table III.). It is interesting to note that in Mr. Herbert's initial year, the food bill was nearly £11 per cow per annum. This year it is over £3 less, an important saving.

Karridale Queen (2754).
Owned by G. E. Scott, "Brookfields," Yarloop.
Produced 9,360 lbs. milk, average test 5·3%, 493·95 lbs. butter fat.
As a Senior Three-year-old—standard 290 lbs. butter fat.

Herd "B," owned by Mr. W. G. Burges, is, with Mr. P. Rose's herd, the largest under the Official Recording Scheme. It will be noticed that for this herd the profit per cow from the sale of butter fat was £10 14s. 4d., or fourth highest for the year. This is a good achievement in view of the fact that this stud is situated in a dry district and that the cows were maintained in milk throughout the whole year, not all freshening during the autumn so as to have the flush of the season during their high milking period. Of necessity the cost of feeding a herd under these conditions is higher than in areas where green feed and pasture are available over a long period, but the actual cost—£10 2s. 3d. per cow—is only 20s. per cow more than the average cost. Such returns, of course, have only been made possible through the high average production of the cows being fed, namely, 378 lb. butter fat per cow.

In Table II. the three breeds under test have been compared as regards productivity and cost of feeding. The Australian Illawarra Shorthorn cows show up particularly well from the point of view of production—it certainly seems as if the numerous importations of recent years from the Eastern States have proved very beneficial to the breed and the State. In past years the Jersey and Guernsey cows have proved very close rivals, but this year the Jersey owners have proved markedly successful in reducing feeding costs. This table shows the Jerseys to be

very economical producers of both milk and butter fat. It is only fair to state that the Guernseys as a breed were handicapped this year by the costly feeding methods of two herds. The Denmark State Farm Guernsey cows, on the other hand, were fed at the low annual cost of £7 19s. per cow.

TABLE 2.—BREEDS COMPARED AS PRODUCERS OF MILK AND BUTTERFAT.

Breed.	Average Yield of Butter Fat per Cow.	Average Test.	Average Yield of Milk per Cow.	Average Cost of Feed per Cow.	Cost of Food to Produce 1 gall. of Milk.	Cost of Food to Produce 1 lb. of Butter Fat.
	lbs.	per cent.	lbs.	£ s. d.		
Jersey (10 herds) ...	296·8	5·1	5,870	7 8 3	3·03	5·99
Guernsey (5 herds) ...	296·1	5·0	5,876	10 8 10	4·26	8·46
A.1 Shorthorn (6 herds)	332·2	4·1	8,072	10 10 2	3·12	7·61

The following is a series of tables showing:—

TABLE 3.—PRICES USED IN VALUATING THE FOODSTUFFS CONSUMED DURING YEAR ENDING JULY, 1933.

Chaff—Oaten or Wheaten		£4 5s. 0d. per ton
Clover Hay		£3 0s. 0d. per ton
Silage		7/– per ton
Wheat (crushed)		3/– per bushel
Oats (crushed)		1/11d. per bushel
Bran		£5 12s. 6. per short ton
Pollard		£5 17s. 6d. per short ton
Linseed Meal		£12 10s. 0d. per short ton
Green Lucerne		£1 0s. 0d. per ton
Green Maize, Sudan Grass	Chaffed	6/– per ton
Cereal Crops	Grazed	2/6 per head per week
Pasture		1/6 per head per week

"Victress of Toora," owned by W. G. Burges, "Tipperary," York. Highest Producing Cow in the Junior Four-year-old Class. Standard, 310 lbs. butter fat. Production, 10,074 lbs. milk; Average test, 4.7 per cent.; 475.48 lbs. butter fat.

TABLE 4.—HERDS IN ORDER OF MERIT AS PRODUCERS OF BUTTER FAT.

Herd.	Breed.	Average Production of Butter Fat per Cow for 9 months.	Average Production of Skim Milk per Cow for 9 months.	Value of Butter Fat at 11d. per lb.	Value of Skim Milk at 11d. per gallon.	Gross Return from Fat and Skim Milk.	Cost of Feed per Cow for 12 months.	Profit per Cow by Sale of Butter Fat.	Cost of Feed to produce 1lb. of Butter Fat.
		lbs.	lbs.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	pence.
A	Guernsey	413·0	7,014	18 18 7	2 18 5	21 17 0	9 17 6	11 19 6	5·74
B	A.I.S.	377·9	8,420	17 6 5	3 10 2	20 16 7	10 2 3	10 14 4	6·42
C	Jersey	374·2	6,367	17 3 0	2 13 0	19 16 0	10 15 0	9 1 0	6·90
D	Guernsey	365·0	5,951	16 14 7	2 9 7	19 4 2	12 9 7	6 14 7	8·20
E	A.I.S.	361·4	7,301	16 11 3	3 0 10	19 12 1	16 18 3	2 13 10	11·23
F	Jersey	348·1	6,148	15 19 1	2 11 3	18 10 4	5 13 6	12 16 10	3·91
G	do.	336·2	5,787	15 18 2	2 8 3	17 16 5	7 17 9	9 18 8	5·63
H	A.I.S.	315·6	6,377	14 9 4	2 13 3	17 2 7	7 19 8	9 2 11	6·08
I	do.	307·2	6,933	14 1 7	2 17 9	16 19 4	10 9 10	6 9 6	8·20
J	do.	306·5	6,789	14 1 0	2 16 7	16 17 7	10 11 10	6 5 9	8·30
K	Jersey	302·2	5,276	13 17 0	2 4 0	16 1 0	9 6 0	6 15 0	7·38
L	A.I.S.	298·7	6,790	13 13 10	2 17 9	16 11 7	8 7 0	8 4 7	6·71
M	Jersey	293·8	5,440	13 9 4	2 5 4	15 14 8	5 0 0	10 14 8	4·08
N	do.	292·0	4,746	13 7 8	1 19 7	15 7 3	9 10 0	5 17 3	7·81
O	Guernsey	286·7	5,383	13 2 10	2 4 10	15 7 8	7 19 0	7 8 8	6·65
P	Jersey	286·4	5,350	13 2 6	2 4 7	15 7 1	7 0 7	8 6 6	5·87
Q	Guernsey	284·3	5,046	13 0 7	2 2 1	15 2 8	11 1 4	4 1 4	9·33
R	Jersey	261·5	4,460	11 19 8	1 17 2	13 16 10	9 11 1	4 5 9	8·77
S	Guernsey	248·4	4,492	11 7 8	1 17 5	13 5 1	11 16 10	1 8 3	11·45
T	Jersey	246·5	4,385	11 6 0	1 16 7	13 2 7	6 16 6	6 6 1	6·65
U	do.	241·3	4,559	11 1 2	1 18 0	12 19 2	7 16 2	5 3 0	7·76
Average		308·6	5,979	14 2 10	2 9 10	16 12 8	9 2 3	7 10 5	7·08

TABLE 5.—HERDS IN ORDER OF MERIT AS PRODUCERS OF MILK.

Herd.	Breed.	Average Yield of Milk per Cow for 9 months.	Value of Whole Milk at 9d. per Gallon.	Cost of Food per Cow for 12 Months.	Profit over Cost of Food.	Cost of Food to Produce 1 gallon of Milk.
		lbs.	£ s. d.	£ s. d.	£ s. d.	pence.
B	A.I.S.	9,356	35 2 0	10 2 3	24 19 9	2·59
E	do.	8,112	30 8 3	16 18 3	13 10 0	5·00
A	Guernsey ...	7,749	29 1 3	9 17 6	19 3 9	3·06
I	A.I.S.	7,703	28 17 6	10 9 10	18 7 8	3·27
L	do.	7,544	28 5 6	8 7 0	19 18 6	2·66
J	do.	7,533	28 5 6	10 11 10	17 13 8	3·37
H	do.	7,086	26 11 6	7 19 8	18 11 10	2·74
C	Jersey	7,074	26 10 3	10 15 0	15 15 3	3·65
F	do.	6,831	25 12 3	5 13 6	19 18 9	1·99
D	Guernsey ...	6,723	25 4 0	12 9 7	12 14 5	4·45
G	Jersey	6,430	24 2 3	7 17 9	16 4 6	2·94
M	do	6,045	22 13 9	5 0 0	17 13 9	1·99
O	Guernsey ...	5,981	22 8 6	7 19 0	14 9 6	3·19
P	Jersey	5,945	22 6 3	7 0 7	15 5 8	2·83
K	do.	5,862	21 19 6	9 6 0	12 13 6	3·81
Q	Guernsey ...	5,607	21 0 9	11 1 4	9 19 5	4·73
N	Jersey	5,273	19 15 3	9 10 0	10 5 3	4·32
U	do.	5,066	19 0 3	7 16 2	11 4 1	3·70
S	Guernsey ...	4,991	18 4 3	11 16 10	6 17 5	5·70
R	Jersey	4,956	18 12 0	9 11 1	9 0 11	4·62
T	do.	4,872	18 5 3	6 16 6	11 8 9	3·36
Average ...	... ...	6,643	24 18 3	9 2 3	15 16 0	3·29

TABLE 6.—SUMMARY OF RESULTS, 1932–33.

The average pure-bred cow under official test produced in nine months:—

1. 6,643 lbs. of Milk.
2. 308·6 lbs. of Butter Fat.

	£ s. d.
Value of Butter Fat at 11d. lb.	14 2 10
Value of Skim Milk at 1d. gallon	2 9 10
Total Return	16 12 8
Cost of Food for 12 months	9 2 3
Net Return from Sale of Butter Fat ...	£7 10 5
Value of Whole Milk at 9d. gallon	24 18 3
Cost of Feed	9 2 3
Net Return by Sale of Whole Milk ...	£15 16 0

Cost of Feed to Produce 1 gallon of Milk = 3·29 pence.

Cost of Feed to Produce 1 lb. of Butter Fat = 7·08 pence.

THRIPS IMAGINIS (BAGNALL).

By

L. J. Newman, Government Entomologist,

H. G. Andrewartha, M.Sc. Agr.,

and

B. A. O'Connor, B.A., B.Sc.Agr.

The Apple Thrips, as this species is usually termed, is at present the most important insect pest with which the growers of deciduous fruits in this State have to contend.

On account of the minute size of the insect, the rapidity of its spread over large areas and the suddenness of attack in great numbers, completely blasting in a few days all prospects for a crop of fruit, the control of this pest is a matter of considerable difficulty. There is no reason to believe, as some have stated, that the insect will disappear in a few years, but is should be regarded as a permanent pest.

The injury is caused by the feeding of the adults on the developing flower buds. The act of depositing the eggs into the flowers also causes further damage. The feeding injury is not produced by a biting or chewing process. By rasping the flowers with their hardened or chitinous mouth parts, the thrips cause an exudation of sap, which they readily suck up.

Thrips imaginis is a native of Australia, and was first described by R. S. Bagnall in 1926. This pest is perennial in its occurrence, being found in its various stages throughout the year. The most damaging swarms make their appearance during the spring and early summer, minor swarms appearing sometimes in the autumn.

This thrip has many host plants, including native, garden, and orchard flowers.

The adult thrips are light to darkish brown in colour and measure slightly less than one-twenty-fifth of an inch in length. They possess two pairs of narrow and extremely delicate wings, fringed with long hairs, and when not in flight they lie along its back. The eggs, which are very minute, are inserted in various parts of the flower by means of the saw-like ovipositor of the female.

The young resemble the adults in general appearance, except that they have no wings, are smaller in size and lighter in colour.

During the past season the loss of fruit by this pest was only slight. This escape was due entirely to natural causes and not to the application of any preventive or remedial measures.

In an endeavour to obtain further information concerning the factors which govern the appearance of this thrip in plague form, a project was prepared. Last year, 1932, the first section of this work was undertaken.

This included the following:—

1. The taking of a thrip census.
2. The recording of the meteorological conditions.
3. The taking of soil temperatures.

These three initial investigations would determine the numbers and species of thrips present in the flowers. The numbers then to be correlated with the prevailing meteorological conditions and the temperature of the soil.

Mt. Barker was selected as the centre for this work.

As a comparative test, in the more northern fruit-growing areas a bi-weekly census was taken at Mundaring. For general information including all fruit districts, arrangements were made with the Superintendent of Horticulture, for his officers to forward at regular intervals thrip-infested material. This included orchard, garden, and native flowers. The collecting of flowers was commenced in February and continued until the end of the following November. The species of thrips present were separated, identified, and their relative numbers noted.

The observations at Mt. Barker were commenced on June 26th, 1932. During June to September 22nd, bi-weekly visits were made. The material collected was brought back to the laboratory, counted, and identified.

On the 22nd September it was decided that Mr. Andrewartha should be stationed at Mt. Barker, this work being continued until the 7th November. This gave opportunity for the taking of a daily census of the thrips, also records of the soil temperature and rainfall, during the critical flowering period of the apple trees.

The outcome of the general and specific collecting proved that the plague thrips (*Thrips imaginis*) occurred in moderate numbers from February to September.

On 19th and 20th October, a sudden burst of hot weather came in (shade temperature 87 deg. F.). This affected all areas from Bridgetown northwards, *Thrips imaginis* appearing in plague form. At this time, as shown by the records taken in the more southern area of Mt. Barker, the temperatures did not rise to the same degree, hence the pest did not swarm.

This was undoubtedly the peak period for 1932 in the Bridgetown, West coastal, and Darling Range country. The average number of *Thrips imaginis* per fruit tree blossom at this period at Mundaring was 24, rising as high as 50 in the Roleystone area and were reported to be swarming in the Bridgetown orchards. The swarm had, however, appeared too late to injure seriously the main setting of fruit. The pest then concentrated on belated blooms and late flowering varieties, causing considerable damage to them. Had the awarm appeared two or three weeks earlier, there is little doubt, judging from the damage done to late apple blossom and roses, that we should have had to record a very serious failure of the apple crop.

A feature observed in the Bridgetown district was the swarming of pre-winged thrips in the belated blossoms, and the partly-closed calyx of the formed fruit.

It was also noted, that blossoms that were well out, when the plague of thrips struck them, set fruit, but blossoms in the pinking stage were totally destroyed.

The numbers of *Thrips imaginis*, in the Mundaring district, had fallen from 24 per blossom on the 20th October to 12 on the 3rd November.

In the Mt. Barker area and southward, the pest did not at any time reach dangerous proportions. The maximum number of thrips per blossom, recorded at Mt. Barker, was 14. This peak period occurred on the 30th October, 10 days later than the plague swarm in the more northern areas.

The relationship of thrip abundance and the flowering of eucalypts was carefully observed.

The year 1932 was a light gum blossom one. The red gum and jarrah, two species suspected of having an important bearing on the breeding up of the thrip population, blossomed very sparsely.

There was no flowering of the jarrah in July, August, September, as occurred in the thrip plague year, 1930. In spite of the lack of gum blossom, a plague swarm of thrips did occur, but, as before mentioned, owing to unfavourable climatic conditions, it appeared too late to effect seriously the main apple blossoming.

This certainly appears to discredit any theory, that the presence or otherwise of *Thrips imaginis*, depends upon the flowering of eucalypts.

The work done at the Mt. Barker and all other districts, from which material was collected and forwarded, gave definite evidence that the chief host plants during June to September were the various species of native and introduced acacias.

The State is very prolific in native acacias, which grow on the country adjacent to our orchard lands. The acacias, unlike the eucalypts, flower profusely every year and thus prove to be a regular carry-over of the thrips, rather than the irregular flowering eucalypts. Besides acacias, this thrips was found breeding and infesting some 15 other native species of flowers, also numerous garden flowers.

The common Cape-weed (*Cryptostemma calendulaceum*) was not at any time found to be heavily infested.

The more specific investigation was carried out at Mt. Barker by Mr. H. G. Andrewartha.

The work was solely concerned with the conduction of a census with the view of correlating thrips numbers with meteorological conditions. From 26th June to 22nd September, samples were taken at approximately fortnightly intervals at Mt. Barker; and from 22nd September to 7th November the samples were taken daily. During the latter period 1in. maximum soil temperatures were also recorded.

During the first period collecting was confined to bush flowers. The following list of plants were examined to obtain the thrips which figure in Table 1. An asterisk indicates that no *Thrips imaginis* were obtained.

Hovea chorizemifolia*
Grevillea Brownii*
Leucopogon verticillata*
Eucalyptus calophylla
Acacia podalyriæfolia
Acacia cyanophylla
Acacia Drummondii
Acacia decurrens
Acacia myrtifolia
Acacia extensa
Acacia pulchella
Daviesia sp.*
Raphanus raphanistrum
Cryptostemma calendulaceum
Hypocalymma angustifolium
Bossiæa linophylla*
Hardenbergia Comptoniana*

TABLE 1.—THRIPS FROM BUSH FLOWERS.

Date.	Thrips Imaginis.				Other Species.	Total.
	Females.		Males.	Larvae.		
	Pale.	Dark.				
27-6-32	...	...	...	...	14	14
18-7-32	9	...	2	34	21	66
1-8-32	49	61	32	...	75	217
18-8-32	38	164	105	...	152	459
29-8-32	45	34	4	3	120	206

At first an attempt was made to form an estimate of the number of thrips per flower on each of the dates occurring in the table, but this proved to be impracticable for the following reasons:—

(a) Most of the species examined only flowered over a limited period and did not last for the full two months of the investigation; further, the individual plants within the species flowered for an even shorter time.

(b) It was found to be very difficult to select flowers of a uniform "freshness", and the age of the flowers (particularly in certain acacias) was found to have a marked effect on the number of thrips they contained; *e.g.*, of two samples of *Acacia podalyriaefolia* taken from the same tree, one consisting of 72 flower heads, contained 265 *Thrips imaginis;* the other, consisting of 120 flower heads, contained no thrips.

Because of this difficulty in obtaining uniform conditions for sampling, the idea of obtaining a quantitative estimate of the thrips population of the bush-flowers during these months was abandoned. Instead, a random sample of thrips was collected from as wide a variety of hosts as possible and arranged into pale and dark females, males and numphs, as shown in Table 1.

From this table several facts emerge:—

(a) *Thrips imaginis* breeds throughout the year—75 per cent. of the samples collected 18/7/32 were nymphs.

(b) The life cycle at this period of the year is fairly protracted. After the sample taken on 18/7/32, the samples for the next month contained no nymphs, and even on 29/8/32 the nymphs only represented 3.5 per cent. of the total samples.

(c) Parthenogenisis is apparently not a feature of reproduction during the winter—all the samples contained some males and that taken on 18 8/32 contained 34.2 per cent. males.

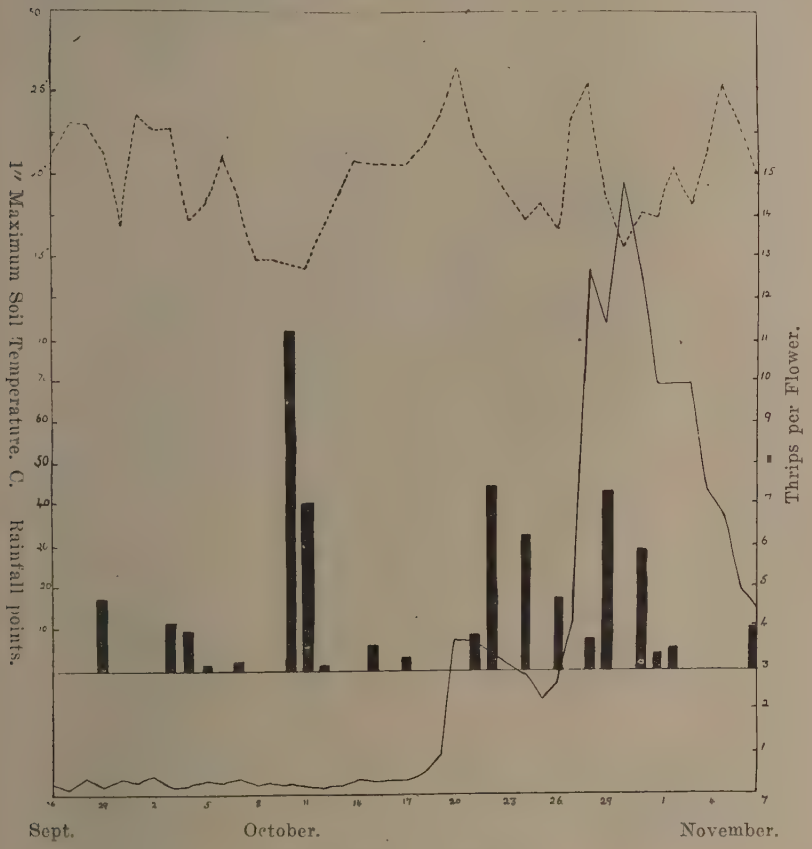
From 26/9/32 daily samples were collected from apple-flowers. The samples were taken from the same three orchards each day. In Table 2 the thrips have been grouped into pale and dark females, males and nymphs, and the one-inch soil temperatures, the maximum shade temperatures, and the rainfall have been added.

TABLE 2.

Date.	Females.		Thrip Imaginis.			Thrips per Flower.	No. of Flowers.	1" Soil Max. C.	Shade Max. C.	Rain Points.
	Pale.	Dark.	Males.	Nymphs.	Total.					
1932.										
September. 26 ...	3	2	...	...	5	0·25	20	21·2	17·2	...
27 ...	5	...	...	...	5	0·12	40	23·3	21·1	...
28 ...	15	2	...	...	17	0·42	40	23·0	18·8	...
29 ...	11	2	...	...	13	0·21	60	21·2	17·7	17
30 ...	19	5	...	...	24	0·40	60	16·9	13·9	...
October 1 ...	13	4	1	...	18	0·30	60	23·6	19·4	...
2 ...	13	6	...	...	19	0·47	40	22·7	...	...
3 ...	14	2	...	...	16	0·20	80	22·7	18·3	12
4 ...	13	6	...	...	19	0·24	80	17·2	13·3	10
5 ...	29	5	...	...	34	0·34	100	18·6	17·7	1
6 ...	18	9	...	...	27	0·27	100	21·3	16·1	...
7 ...	29	8	1	3	41	0·41	100	18·6	14·4	2
8 ...	27	5	...	1	33	0·33	100	14·7	11·7	...
9 ...	...	...	...	...	...	...	...	14·7	...	...
10 ...	...	...	...	...	...	...	...	...	12·2	82
11 ...	12	6	...	6	24	0·24	100	14·2	12·2	40
12 ...	15	3	...	3	21	0·18	120	16·6	14·4	1
13 ...	18	6	...	2	26	0·26	100	18·9	16·1	...
14 ...	22	11	6	6	45	0·45	100	20·8	20·0	...
15 ...	17	13	1	1	32	0·32	100	20·5	19·4	9
16 ...	...	...	...	...	...	...	...	...	...	...
17 ...	17	20	1	6	44	0·38	120	20·5	17·7	5
18 ...	10	6	10	12	38	0·32	120	21·6	20·5	...
19 ...	42	40	23	14	119	0·99	120	23·5	22·8	...
20 ...	260	48	53	12	373	3·73	100	26·6	26·6	...
21 ...	244	50	56	19	369	3·07	120	22·2	20·0	...
22 ...	...	...	...	...	...	...	...	...	...	...
23 ...	...	...	...	...	...	...	...	...	...	10
24 ...	238	47	41	12	338	2·82	120	17·2	17·7	45
25 ...	37	6	3	...	46	2·30	20	18·3	17·2	...
26 ...	205	27	31	2	265	2·65	100	16·4	15·5	17
27 ...	299	59	58	2	426	4·26	100	23·3	18·3	...
28 ...	851	64	63	...	978	12·22	80	25·5	25·5	7
29 ...	196	13	18	...	227	11·43	20	18·9	16·1	40
30 ...	517	37	40	...	594	14·85	40	15·5	...	...
31 ...	870	76	52	...	998	12·47	80	17·0	13·3	29
November 1 ...	685	61	47	...	793	9·91	80	17·2	22·2	4
2 ...	...	...	...	...	...	...	...	20·5	18·3	5
3 ...	528	37	32	...	597	9·95	60	18·3	15·5	...
4 ...	377	39	22	4	442	7·36	60	21·2	18·3	...
5 ...	302	36	52	3	393	6·66	60	25·5	23·9	...
6 ...	146	14	35	1	196	4·90	40	23·9	...	...
7 ...	142	12	23	3	180	4·50	40	19·4	17·2	9

Fig. I.

This figure is based upon the data given in Table II. The continuous line represents the number of Thrips imaginis per flower. The broken line maximum 1" soil temperatures, the black lines the rainfall.



Thrips Census, Mt. Barker, 1932.

The one-inch soil temperature followed the shade temperatures fairly closely, but remained consistently 2 deg. to 3 deg. higher.

The temperatures during October were consistently low. Only twice did the shade temperature reach 25 deg. C. (77 deg. F.), and on each occasion the hot spell lasted for only two days. The mean daily temperature for the month was 55.5 deg. F. (13.0 deg. C.).

The total rainfall for the month of October was 329 points, spread over 15 days. The average October rainfall for 39 years is 296 points.

A further idea of the weather conditions can be formed from the weather bureau's classification of cloud conditions into "fine", "cloudy" and "overcast". Of the 26 records made (Sunday conditions are not recorded), there were 13 days overcast, 3 days cloudy, and 10 days fine.

The number of thrips remained fairly constant at about 0.3 per blossom from 26/9/32 until 18/10/32. This does not mean that the actual numbers of thirps remained so steady, since the amount of apple blossom in the orchards was steadily increasing during this period. But it does mean that the increases in the thrips was a very steady and gradual one. Then on the 20th, following a soil temperature of 26.6 deg. C. (80 deg. F.), the numbers jumped up to 3.7 per blossom. This represented an increase of about 350 per cent. in one day or nearly 900 per cent. in two days. There followed a spell of cool cloudy, rainy weather, during which the thrips remained constant at about 3 to a blossom. Following a soil temperature of 25.5 deg. C. (78 deg. F.) on the 27th, the numbers jumped up to 12.2 per blossom on the 28th. This represented an increase of 200 per cent. in one day or nearly 500 per cent. in two days. The temperature on the 29th dropped to 18.9 deg. C. and the weather remained cool and cloudy until 7/11/32, when the census was concluded. During this period, following the peak, on the 28th, the numbers declined steadily from 12 to 4.5 per blossom on 7/11/32.

Although these figures are dealing only with comparatively small numbers of thrips (too few to constitute a menace), they serve to indicate very clearly the effect of a sudden hot spell upon the numbers of thrips in the blossoms. They show why, in a plague year, the swarms appear with such devastating suddenness.

The relative scarcity of *Thrips imaginis* in Mt. Barker this year might possibly have been the outcome of any or all of the following factors:—

(a) The winter "carry-over" may have been too slender to provide a swarm.

(b) The weather conditions during September and October may not have been suitable.

(c) There may have been a scarcity of food in the bush during September and early October.

That either (a) or (c) were of any importance would seem to be negatived by observations taken at Bridgetown on 6/9/32, as set out in Table 3.

Table 3.

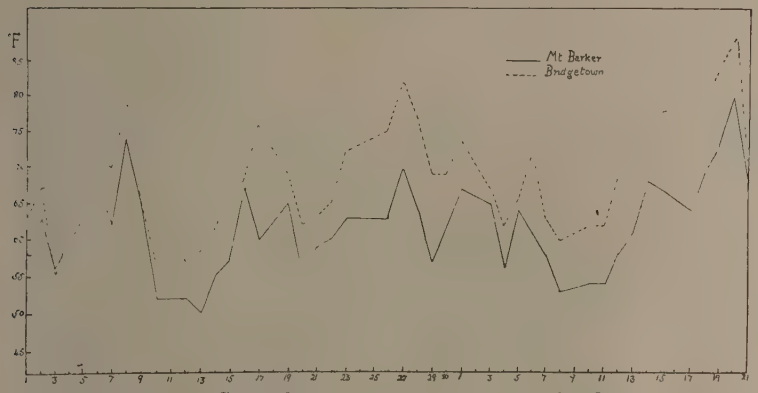
	Acacia pulchella (3,000 heads).	Acacia cyanophylla (1,000 heads).	Eucalyptus cladocalyx (20 flowers).	Total.
Thrips tabaci	1	1	...	2
Odontothrips australis	2	...	...	2
Isoneurothrips australis	5	3	16	24
Physothrips sp.	81	1	...	82
Thrips imaginis	...	...	...	...
Total	89	5	16	110

Altogether 3,000 heads of *Acacia pulchella*, 1,000 heads of *Acacia cyanophylla*, and 20 flowers of *Eucalyptus cladocalyx* were examined, but did not yield a single *Thrips imaginis*.

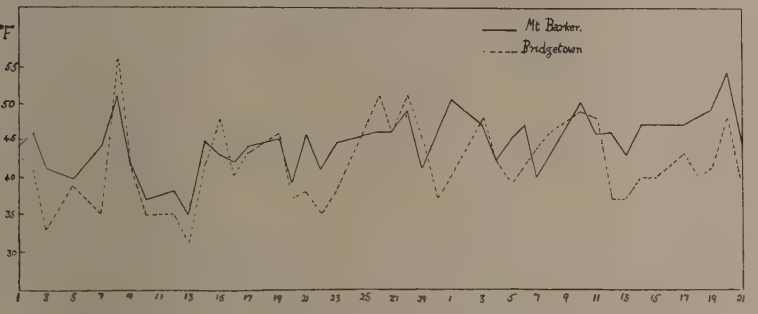
When these figures are compared with those set out in Table IV., which shows the results of collecting done in Mt. Barker on 29/8/32, it is immediately apparent that the winter "carry-over" was more slender in Bridgetown than in Mt. Barker —and yet, on 19/10/32 thrips swarmed in Bridgetown, whereas in Mt. Barker they never reached plague numbers.

Daily **Maximum Shade** Temperatures.

Fig. II.



Note that the Bridgetown temperatures were consistently higher during the whole period from September 1st to October 21st. Compare this with Fig. III.



Daily Minimum Shade Temperatures.

Fig. 3.—Note that the Bridgetown minimum temperatures are mostly lower than those for Mt. Barker. This is associated with the bright days and consistently higher maxima recorded at Bridgetown. (See Fig. 2.)

September. October.

TABLE 4.

	Acacia pulchella (500 heads).	Acacia cyanophylla (2,000 heads).	Acacia extensa (1,000 heads).	Total.
Physcthrips sp.	3	1	8	12
Isoneurothrips australis	...	30	...	30
Odontothrips australis	...	2	...	2
Thrips imaginis	...	13	27	50

It would therefore seem that of the three factors enunciated above, (b) must be the important one.

Just how the weather conditions operated to prevent swarming of thrips is not too plain. Apparently there were two factors operating:—

(a) The low temperatures slowed down development very greatly.

(b) There are indications that there was a fairly high mortality during October.

The conclusion that there was a high mortality during October depends upon the assumption that females of *Thrip imaginis* change from a pale yellow to a dark brown within a few days of emerging from the soil. In Table 5, the ratio of dark to pale females collected during October is set out.

The interesting thing about these figures is the persistently low ratio of dark to pale females. The only occasion when it rises above unity is on 17/10/32. For the rest of the time it is considerably below unity. Taken in conjunction with the comparative steadiness of the figures for total thrips population, this ratio must indicate a considerable mortality of newly emerged adult females (if the above assumption holds good).

The very pronounced scarcity of nymphs, particularly after about 25/10/32, would also bear this out, as there are only two possible explanations for it. Either the adults were dying before laying many eggs, or else there was a high mortality among the nymphs. Probably both factors were operating.

Table 5.—RATIO OF DARK TO PALE FEMALES.

Date.	Ratio—Dark to Pale.	Date.	Ratio—Dark to Pale.	Date.	Ratio—Dark to Pale.
October 1 ...	0·3	October 12 ...	0·2	October 22 ...	...
2 ...	0·4	13 ...	0·3	23 ...	...
3 ...	0·1	14 ...	0·5	24 ...	0·2
4 ...	0·1	15 ...	0·8	25 ...	0·2
5 ...	0·2	16 ...	...	26 ...	0·1
6 ...	0·5	17 ...	1·2	27 ...	0·2
7 ...	0·3	18 ...	0·6	28 ...	0·1
8 ...	0·2	19 ...	0·9	29 ...	0·1
9 ...	...	20 ...	0·2	30 ...	0·1
10 ...	...	21 ...	0·2	31 ...	0·1
11 ...	0·3				

Summarising the facts as set out above, we have the following conclusions:—

(a) *Thrips imaginis* breeds slowly throughout the winter months, its principal host flowers during this period being the many native flowering plants, with a distinct preference for plants of the genus acacia.

(b) It has been demonstrated that a swarm may occur, though the winter carry-over is exceedingly slender, as at Bridgetown last winter.

(c) Even though the winter carry over is comparatively large, meteorological conditions during September-October may prevent swarming, as in Mt. Barker last spring.

(d) The prevailing low temperatures (operating to increase the period of development and thus decrease the numbers of generations) were at least partially responsible for the absence of swarming at Mt. Barker.

(e) There is, however, some evidence that there was a high mortality amongst certain stages—particularly newly emerged females.

(f) This mortality (if it occurred) was probably the outcome of adverse meteorological conditions, but just what factors were responsible is not yet too plain.

(g) Given early favourable weather conditions, there are possibilties of a damaging plague of thrips any spring.

(h) The peak swarm on the 19th and 20th October, 1932, appeared too late to cause serious damage, except to belated or late-flowering varieties of apples.

(i) In the districts from Mt. Barker south, the pest did not at any period reach damaging numbers.

In the taking of the thrips census numerous species other than *Thrips imaginis* were identified and recorded.

Amongst those species found, the following were most numerous:—*Isoneurothrips australis,* numerous in the months of February, March, and June. Present in moderate numbers during the remaining months of the year. In June, July, and August, the dark form predominated.

Chief food plants, eucalyptus and other bush flowers, few in cultivated flowers.

Thrips tabaci, moderate numbers throughout the year.

Main host plants, cultivated flowers, vegetables and miscellaneous bush flowers.

Odontothrips australis, numerous March to May, moderate June to September. Host plants, acacias, hovea and other native legumes. Few in cultivated flowers.

Frankliniella insularis, moderate October to January, numerous February, March, April, May, much reduced, June to September only slightly in evidence.

Host plants, garden flowers, and few in eucalyptus.

Microcephalothrips abdominalis, small numbers, February to May, garden flowers.

The complete list of *Thysanoptera* collected during the year is given hereunder.

RECORDS OF THYSANOPTERA.

Species.	Host Plant.	Locality.	Date.
Thrips imaginis (Bag.) ...	Eucalyptus spp.	Belmont	29-2-32, 7-4-32
		Spearwood	2-3-32
		Baker's Hill ...	7-3-32
		Gosnells	12-3-32
		Harvey	14-3-32
	Acacia podalyriaefolia ...	Perth	16-5-32
		Bayswater	27-7-32
	Acacia baileyana	Caversham	27-7-32
		Bedfordale	25-8-32
	Acacia cyanophylla	Narrogin	17-8-32
		Mt. Barker	29-8-32
		Mundaring	30-9-32
	Acacia microbotrya	Perth	26-8-32
	Acacia extensa	Mt. Barker	29-8-32
	Acacia alata	Kalamunda	16-9-32
	Acacia pulchella	Lesmurdie	22-9-32
		Mundaring	30-9-32
	Acacia oncinophylla	Lesmurdie	22-9-32
	Acacia saligna	Narrogin	3-10-32
	Acacia spp.	Mundaring	5-7-32
		Bedfordale	13-7-32
		Wooroloo	22-8-32, 21-9-32
		Wanneroo	23-8-32
		Jandakot	26-8-32
		Spearwood	30-8-32
	Eucalyptus calophylla ...	Mundaring	9-5-32
	Eucalyptus rudis	Wooroloo	22-8-32
		Kelmscott	15-10-32
	Hypocalymma angustifolia ...	Mundaring	30-9-32
	Agonis linearifolia	Kelmscott	15-10-32
	Hakea prostrata	Spearwood	21-10-32
	Dryandra floribunda	Spearwood	21-10-32
	Melaleuca radula	Lesmurdie	22-9-32
	Raphanus raphanistrum ...	Mundaring	5-7-32
	Rosa spp.	Bridgetown	29-2-32
		Bayswater	6-7-32
		Perth	26-8-32
	Nerium oleander	Bridgetown	29-2-32
	Dahlia spp.	Guildford	9-4-32
	Eriobotrya japonica (loquat) ...	Mundaring	30-5-32, 13-6-32
		Clontarf	4-6-32
	Citrus limonia	Mundaring	13-6-32

RECORDS OF THYSANOPTERA—*continued.*

Species.	Host Plant.	Locality.	Date.
Thrips imaginis (Bag.) ...	Chrysanthemum coronarium (marguerite)	Maida vale	21-10-32
	Prunus persico (peach) ...	Mundaring	30-9-32
	Prunus avium (cherry) ...	Mundaring	30-9-32
	Pyrus communis (pear) ...	Mundaring	30-9-32, 19-10-32
	Prunus salicina (jap plum) ...	Mundaring	30-9-32
	Pyrus malus (apple)	Mundaring	19-10-32, 3-11-32
		Karragullen	1-11-32
		Kalgan River ...	28-10-32
	Miscellaneous garden flowers ...	Belmont	7-3-33
		Mundaring	9-5-32
		Perth	14-6-32
	Miscellaneous wild flowers ...	Maida Vale	17-6-32
		Denmark	6-7-32
		Narrogin	26-8-32
		Harvey	24-8-32
		Mt. Barker	12-9-32, 19-9-32
		Mundaring	12-9-32
	Unspecified	Albany	7-7-32
Thrips tabaci (Lind.) ...	Rubus fruticosus	Bridgetown	29-2-32
	Acacia podalyriaefolia ...	Perth	16-5-32
	Acacia pulchella	Bridgetown	6-9-32
		Harvey	24-9-32
	Acacia cyanophylla	Bridgetown	6-9-32
	Acacia sp.	Spearwood	30-8-32
	Olearia paucidentata	Kalamunda	3-5-32
	Kennedya prostrata	West Swan	25-6-32, 24-9-32
	Raphanus raphanistrum ...	Mundaring	5-7-32
	Rosa spp.	Bridgetown	29-2-32
	Nerium oleander	Bridgetown	29-2-32
	Dahlia sp.	Guildford	9-4-32
	Allium cepa (leaves)	Mundaring	5-7-32
	Ageratum sp.	Bayswater	6-8-32
	Lupinus sp.	West Swan	24-9-32
	Chrysanthemum coronarium (Marguerite)	Maida Vale	21-10-32
	Eucalyptus sp.	Harvey	14-4-32
	Miscellaneous garden flowers ...	Belmont	7-3-32, 10-5-32
		Queen's Park ...	6-4-32
		Serpentine	10-4-32
		Mundaring	9-5-32
		Perth	18-5-32, 14-6-32
		Bayswater	4-6-32
		Denmark	6-7-32
		Narrogin	17-8-32
		Mt. Barker	19-8-32
	Miscellaneous Bush flowers ...	Mundaring	13-5-32, 12-9-32
		Bedfordale	13-7-32
		Midland Junction ..	12-8-32
		Harvey	24-8-32
		Mt. Barker	19-9-32
		Kalgan River ...	28-10-32
Isoneurothrips australis (Bag.)	Eucalyptus calophylla ...	Bicton	11-5-32
		Mundaring	9-5-32
		Belmont	19-5-32
		Bridgetown	20-5-32
	Eucalyptus rudis	Gosnells	25-6-32
		Wooroloo	22-8-32, 21-9-32
		Wanneroo	22-9-32
		Kelmscott	15-10-32
	Eucalyptus cladocalyx ...	Bridgetown	6-9-32
	Eucalyptus spp.	Belmont	29-2-32, 7-3-32, 6-4-32, 7-4-32
		Baker's Hill	7-3-32
		Gosnells	12-3-32
		Harvey	14-3-32, 14-4-32
		Mundaring	30-5-32
		Bridgetown	15-6-32
		Denmark	6-7-32
		Wanneroo	23-8-32
	Acacia Baileyana	Caversham	27-7-32
		Bridgetown	19-8-32
	Acacia cyanophylla	Mt. Barker	29-8-32
		Bridgetown	6-9-32
	Acacia pulchella	Bridgetown	6-9-32
		Harvey	24-9-32
	Acacia spp.	Mundaring	5-7-32, 30-5-32
		Wanneroo	23-8-32
	Eriobotrya Japonica (loquat) ...	Mundaring	13-6-32
	Agonis linearifolia	Kelmscott	15-10-32
	Prunus avium (cherry) ...	Mundaring	30-9-32
	Pyrus communis (pear) ...	Mundaring	30-9-32
	Prunus salicina (Jap. plum) ...	Mundaring	30-9-32
	Rosa sp.	Bayswater	6-8-32
	Miscellaneous Bush flowers ...	Toodyay	11-4-32
		Bibra Lake	22-4-32

RECORDS OF THYSANOPTERA—*continued.*

Species of Thrip.	Host Plant.	Locality.	Date.
Isoneurothrips australis (Bag.)	Miscellaneous Bush flowers ...	Mundaring	30–5–32, 12–9–32
		Harvey	24–8–32
		Albany	6–9–32
		Mt. Barker	19–9–32
	Miscellaneous garden flowers ...	Belmont	7–3–32
		Mundaring	9–5–32
		Denmark	6–7–32
Odontothripella australis (Bag.)	Acacia podalyriaefolia ...	Perth	16–5–32
	Acacia cyanophylla	Mt. Barker	29–8–32
	Acacia Baileyana	Bedfordale	25–8–32
	Acacia pilchella...	Bridgetown	6–9–32
	Hovea trisperma	Maida Vale	17–6–32
	Hoveaspp.	Mundaring	30–5–32
		Bedfordale	13–7–32
	Kenneyda prostrata	West Swan	25–6–32, 24–9–32
	Daviesia pectinata	Canningtou	24–6–32
	Hardenbergia	West Swan	29–7–32
	Comptoniana	Guildford	10–9–32
	Oxylobium capitatum ...	West Swan	13–8–32
	Oxylobium cuneatum	Mundaring	19–10–32
	Banksia Menziesii	Gnangara	16–6–32
	Raphanus raphanistrum ...	Mundaring	5–7–32
	Miscellaneous Wild flowers ...	Mundaring	30–5–32
		Maida Vale	8–8–32
	Micesllaneous garden flowers ...	Perth	18–5–32
		Kelmscott	16–9–32
Taeniothrips breviocornis (Bag.)	Hypochœris radicata	Bridgetown	29–2–32
	Acacia pulchella	Harvey	24–9–32
	Eucalyptus sp.	Belmont	6–4–32
	Rosa sp.	Bridgetown	29–2–32
	Miscellaneous garden flowers	Queen's Park ...	6–4–32
Taeniothrips seticollis (Bag.)	Acacia sp.	Mundaring	5–7–32
Taeniothrips spp.	Acacia Baileyana	Caversham	27 7–32
	Acacia pulchella	Mt. Barker	29–8–32
		Bridgetown	6–9–32
	Acacia cyanophylla	Mt. Barker	29–8–32
		Bridgetown	6–9–32
	Acacia extensa	Mt. Barker	29–8–32
	Acacia alata	Kelmscott	16–9–32
	Eucalyptus rudis	Wooroloo	22–8–32
	Ageratum sp.	Bayswater	6–8–32
	Chrysanthemum coronarium ... (Marguerite)	Maida Vale	21 10–32
	Miscellaneous wild flowers ...	Harvey	24–8–32
		Kalgan River ...	28–10–32
Microcephalothrips abdominalis	Zinnia elegans	Guildford	23–4–32
	Dahlia sp.	Perth	5–4–32
		Belmont	29–2–32, 7–3 32
	Miscellaneous garden flowers ...	Maylands	10–5–32
		Perth	18 5–32
Taeniothrips gladioli ...	Gladiolus sp.	Perth	28th Dec.
Isochaetothrips ignobilis ...	Eucalyptus sp.	Northam	11–4–32
Isochaetothrips uniformis ...	... ...	Perth	24–1 –31
Frankliniella insularis (Frank.)	Dahlia spp.	Perth	5–4–32
		Guildford	9–4–32
	Zinnia elegans	Guildford	23–4–32
	Eucalyptus sp.	Belmont	6–4–32, 7–4–32
	Miscellaneous garden flowers	Belmont	29–2–32, 7–3–32
		Gosnells	12–3–32
		Narrogin	6–4–32
		Queen's Park ...	6–4 32
		Serpentine	10 4 32
		Maylands	10–5–32
Frankliniella nigripes ...	Miscellaneous garden flowers	Perth	18–5–32, 14–6–32
		Bayswater	4–6 32
Scholothrips sexmaculatus	Pyrus Malus (apple leaves) ...	Bridgetown	29–2–32
(Pergande)	Solanum nigrum (leaves) ...	Bridgetown	29–2–32
	Salvia leaves	Perth	14–4–32
	Convolvulus leaves	Guildford	...
Glaucothrips sp.	Miscellaneous garden flowers ...	Perth	14–6–32
Limothrips cerealium (Hal.)	Trifolium spp.	Guildford	13–11–32
Limothrips angulicornis (Jab.)	Unspecified	Claremont	24–11–32

RECORDS OF THYSANOPTERA—*continued.*

Species.	Host Plant.	Locality.	Date.
Anaphothrips	Acacia sp.	Jandakot	26-8-32
Anaphothrips newmani (Moulton)	Distorted leaves of Acacia sp. ...	Claremont	15-3-32
Anaphothrips varii (Moulton)	Trifolium spp.	Guildford	13-10-32
Pseudonaphothrips achaetus	Oxylobium capitatum ...	West Swan	13-8-32
	Rosa sp.	Guildford	29-1-32
	Miscellaneous wild flowers ...	Toodyay	11-4-32
		Maida Vale	17-6-32, 12-9-32
		Albany	6-9-32
		Mt. Barker	12-9-32
		Mundaring	12-9-32
		Kalgan River ...	28-10-32
	Miscellaneous garden flowers	Mundaring	9-5-32
Scirtothrips australiae ...	Leaf of Cyclamen indicum ...	Perth	29-4-32
Neophysopus sp.	Acacia pulchella	Mundaring	30-9-32
Agerothrips sp.	Miscellaneous wild flowers ...	Mt. Barker	19-9-32
Australothrips, bicolor (Bag.)	Eucalyptus rudis (leaves) ...	Perth	Feb., 1931
	Hypocalymma angustifolium ...	Mt. Barker	12-9-32
	Eucalyptus calophylla ...	Mundaring	9-5-32
	Eucalyptus sp.	Baker's Hill ...	7-3-32
Heliothrips haemorrhoidalis (Bouche)	Vitis vinifera (grape vine) ...	Nedlands	13-1-31
	Quercus sp.	Perth	1931
	Acacia podalyriaefloia ...	Perth	16-5-32
Hercothrips bifasciipennis (Gir.)	Eucalyptus sp.	Baker's Hill	7-3-32
	Dahlia sp.	Claremont	28th Dec.
Parthnothrips dracaenae (Heeger)	Dracaena sp.	Perth	29-6-32

AEOLOTHRIPIDAE.

Desmothrips australis (Bag.)	Eucalyptus calophylla ...	Mundaring	9-5-32
	Acacia sp.	Spearwood	30-8-32
	Dahlia sp.	Perth	5-4-32
	Blossoms of native trees ...	Toodyay	11-4-32
Desmothrips mendozai (Gir.)	Sweepings in bush	Mundaring	25-2-31
Desmothrips sp.	Oxylobium cuneatum	Mundaring	19-10-32
Melanthrips spp.	Acacia pulchella	Lesmurdie	22-9-32
	Acacia sp.	Jandakot	26-8-31
Cranothrips poultoni (Bag.)	Banksia Menziesii	Belmont	7-4-32
		Bibra Lake	22-4-32
		Gnangara	16-6-32
	Eucalyptus sp.	Belmont	6-4-32
Lamprothrips maculosus (Moulton) (n.g. and n. sp.)	Eucalyptus rudis	Perth	20-12-28
Cranothrips spp.	Hakea prostrata	Jandakot	26-8-32
		Spearwood	21-10-32
	Miscellaneous wild flowers ...	Wooroloo	22-8-32
	Chiefly Hakea spp. and Acacia spp.	Narrogin	26-8-32
		Albany	6-9-32
		(Unrecorded) ...	4-8-32
	(Unrecorded)	Albany	7-7-32
	Melaleuca radula	Lesmurdie	22-9-32
Rhipidothrips aureus ...	Eucalyptus calophylla ...	Mundaring	9-5-32
	Eucalyptus spp.	Baker's Hill	7-3-32
		Gosnells	12-3-32
	Blossoms of native trees ...	Toodyay	11-4-32
	Eucalyptus spp. and Acacia spp.	Mundaring	30-5-32
Liothrips atratus (Moulton)	Sweepings in bush	Mundaring	25-2-31
Haplothrips victoriensis (Bag.)	Garden flowers	Perth	14-4-32
	Do.	Belmont	7-3-32
	Do.	Queen's Park ...	6-4-32
	Dahlias	Perth	5-4-32
	Roses	Bridgetown	29-2-32
	Eucalyptus erythrocoris ...	Perth	10-3-32
	Eucalyptus sp.	Northam	11-9-32
		Baker's Hill ...	7-3-32
Haplothrips gowdeyi ...	Globe amaranthus	Perth	7-3-32
Haplothrips varius ...	Globe amaranthus	Perth	7-3-32
Haplothrips melanocerus ...	Garden flowers	Perth	27-2-32
Phaulothrips fuscus (Moulton)	Eucalyptus sp.	Bridgetown	15-11-27

ACKNOWLEDGMENTS.

For assistance in the identification of the species of thrips collected during the taking of the census, we are indebted to Messrs. Dudley Moulton, of California, and A. A. Girault, of Queensland.

For the naming of the host plants to our botany branch.

For financial aid in carrying out the work herein recorded we have to thank the West Australian Fruitgrowers' Association for the donation of £25.

ERRATA. noted XXI, 569

In the June issue of this Journal, page 246, spraying calendar for fruit trees, under the heading "Plague Thrips", appears a formula credited to Mr. W. Evans, officer of the Council for Scientific and Industrial Research. This should read one part of Pyrethrum to 8 parts of Flowers of Sulphur.

Also on page 249, under heading "Loquat—Soft Brown Scale," should read spray with white oil when scale present.

BACTERIAL WILT OF TOMATOES AND OTHER SOLANACEOUS CROPS.

H. A. Pittman, B.Sc.Agr., Plant Pathologist.

This disease is caused by the bacterial parasite, *Bacillus solanacearum.*

The organism attacks tomato, tobacco, peanut, eggplant, pepper, soybeans, geraniums, beans, potatoes, and many other cultivated plants widely separated botanically. On potato "vines" and the stems of the other plants mentioned, it causes a disease known as "bacterial wilt," and in potato tubers the disease known as "brown rot," "bacterial wet rot," "sore eye" disease, and so on.

It has only been recorded in this State on potatoes and tomatoes. Specimens of tomato plants affected by the disease have recently been received from Geraldton, in which area it may easily become a serious menace to the tomato-growing industry unless the proper precautions are taken by the growers concerned.

It causes a brown discolouration of the vascular ring of potato tubers from which, after cutting, if considerable pressure is used, bacterial slime may often be squeezed out. The bacterial slime becomes very obvious after leaving the cut sections of the potato tuber standing overnight in a moist jar. The bacteria work outwards and inwards from the vascular ring and in the course of time give rise to a soft rot of potato tubers, which often has a very objectionable odour. Sometimes the bacteria invade the eyes of tubers from the vascular ring and bacterial slime exudes. This is the "Sore Eye" condition.

The disease is often introduced on to a hitherto disease-free property in infected potato tubers.

In the stems of plants it causes a brown discolouration of the water-conducting tissues, which is not usually so dark coloured and is wetter-looking than in the case of Fusarium wilts.

Affected plants soon wilt and eventually die. The wilting may commence at any part of the above-ground portions of the plant, and an interesting feature is that a leaf or two may be badly wilted in the early stages of the disease while the rest of the plant is quite turgid (stiff) and looks the picture of health. The leaves do not usually die from the bottom of the plant upwards as is generally the case with Fusarium Wilt of tomatoes.

The disease may enter the plants through roots injured at transplanting time or by cultivation. It may also enter through eelworm galls on the roots. Another method is by means of chewing insects which may spread the disease from plant to plant. The disease may also be transmitted on the hands of workers during the pruning operations.

It is a disease of fairly high temperatures, thriving best at about 95 deg. F. Wet weather with high temperatures favours its development. In the Eastern United States it seems to be most prevalent on washed sandy soils which contain coarse gravel. The disease has been of considerable importance in potato crops grown on the sandy soils around Perth, especially where "round" seed has been planted, but little has been heard of it on heavy soils.

CONTROL.

1. Disinfect tomato seed in corrosive sublimate before planting, as fully indicated in Leaflet 336, obtainable free of charge on application to this Department. The same applies to potato "seed" which should be disinfected before cutting into setts. (See Leaflets 336 and 72, 2nd edition.)

2. Disinfect the seedbeds with formalin, as indicated in Leaflet 336, or else use an entirely new seedbed each year made up from soil on which no susceptible crops have been grown at any time, or for as long a period as possible.

3. Use rotation of crops; that is plant out into fields on which susceptible crops have either never been grown or have not been grown for 4 or 5 years, if possible.

4. Pull up all diseased plants as soon as noticed, "lock, stock and barrel," and destroy by burning or boiling.

5. Wash the hands carefully with soap after handling diseased plants and before touching any further healthy ones, so as to avoid spreading the organism while pruning, picking the fruits, etc.

6. When cutting potato tubers, have two knives, each standing in a separate container with the blade immersed in 10 per cent. formalin (say, 2 ounces formalin plus water to make 1 pint). As soon as a potato with any evidence of disease internally is cut, discard the potato and place the knife which has just been used into the formalin solution.

Then take the other knife out of its container and proceed to cut other tubers until further trouble is met with, when the procedure should be reversed.

7. Destroy all diseased tubers by boiling or by burying deeply in a place where they will not subsequently be disturbed and from where there will be no danger of infection being spread by flood, irrigation, or seepage, waters etc., later on.

8. Do not used "round" potato seed (that is, small, so-called "seed" potatoes), as if there is any disease present internally in some of the tubers, it often cannot be detected except by cutting. Use large tubers cut up into setts whenever there is any doubt about the freedom of the seed from internal visible or invisible parasites (viruses).

9. If the farm offers a variation in the types of soil, it is well to avoid coarse gravel or sand and select for the potato or tomato field a loam with plenty of humus.

10. Potatoes grown in relatively cool areas as, say, the Albany-Denmark area, should preferable be used for seed as this seed is grown under climatic conditions less favourable to the disease than is the case with hotter districts.

11. When obtaining potato "seed" or tomato seed, always obtain it, if possible, from disease-free crops. The same applies, of course, to the seed of any other plants.

12. So far as is known, this disease cannot be controlled by spraying with fungicides such as Bordeaux mixture or lime sulphur. Chewing insects which may spread it about, however, should be controlled by the use of arsenate of lead sprays or dusts or in some other suitable manner.

RELATIVE FOOD VALUES.

RELATIVE VALUES OF CONCENTRATES.

PERTH, SEPTEMBER, 1933.

Foodstuff.	Cost.	Cost per 100 lbs.	Starch equivalent per 100 lbs.	Digestible Protein per 100 lbs.	Cost per lb. of Starch equivalent.	Cost per lb. of Digestible protein.
		s. d.			d.	d.
Wheat ...	3s. per qushel of 60 lbs.	5 0	73	9·0	0·82	6·6
Oats ...	2s. per bushel of 40 lbs.	5 0	63	7·0	0·95	8·6
Bran ...	£5 12s. 6d. per ton	5 7½	48	13·0	1·40	5·2
Pollard ...	£5 17s. 6d. per ton	6 10½	61	13·5	1·15	5·2
Linseed Meal	14s. 6d. per 100lbs.	14 6	72	25·5	2·42	7·0
Meat Meal ...	15s. 6d. per 100lbs.	15 6	92	60·0	2·00	3·1
Peas ...	5s. per bushel of 60 lbs.	8 4	74	19·0	1·35	5·3

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

RECENT PUBLICATIONS.

The following pamphlets and bulletins of the Council have recently been issued and are obtainable, post free, on application to the Department of Agriculture:—

Pamphlet No. 38.—"The Occurrence of *Anaplasma marginale*, Theiler, 1910, in Northern Queensland," by J. Legg, D.V.Sc.

Pamphlet No. 39.—"The Grasslands of Australia and Some of their Problems: A Report upon the Dairy Pastures," by William Davies, M.Sc., Empire Grassland Investigator, Welsh Plant Breeding Station, University College of Wales, Aberystwyth.

Pamphlet No. 40.—"A Guide to the Seasoning of Australian Timbers," Part 1, by C. Sibley Elliott, B.Sc., Division of Forest Products.

Pamphlet No. 41.—"The Grading of Western Australian Timbers: Report on and suggested specifications for the grading of Jarrah and Karri, based on investigations in 1932," by F. Gregson, B.E., and R. F. Turnbull, B.E.

Bulletin No. 75.—*Nigrospora Musae n.sp.* and its connection with "Squirter" Disease in Bananas.

The August number of the Journal of the Council has also been issued. This is a quarterly publication giving progress reports on investigations not yet sufficiently advanced for publication in a final form. In addition, notes on the research activities of the Council are given. The annual subscription to the Journal is 5s., which should be forwarded to the Secretary, Council for Scientific and Industrial Research, 314 Albert Street, East Melbourne.

THE INFLUENCE OF RAMS ON THE FLOCK.

Hugh McCallum, Sheep and Wool Inspector.

Rising wool prices should put new life into the sheep industry and induce sheep farmers to concentrate on the further improvement of their flocks.

In flock improvement the rams, if carefully selected, will play a very important part. They should be purchased from one of our registered stud-breeders who, generally speaking, are men who have made a life-long study of sheep-breeding or who, at least, have a far wider experience in sheep-raising than the average farmer. In purchasing from these breeders a sheep farmer, in addition to obtaining his annual supplies of rams, is gaining the benefit of their wider experience.

Again, he may be relatively sure of purchasing a ram of sound constitution. This quality in a sheep is of fundamental importance and is largely the product of hereditory influences which stud-breeders develop in their systems of breeding.

The system of registered breeding has one other great advantage. It enables flock owners, by referring to the register of Merino stud flocks (which is issued annually by the central organisations of stud-breeders throughout the Commonwealth), to select and purchase from a breeder whose flock was founded on a blood strain akin to that to which his breeding ewes belong. Having selected a breeder whose rams give satisfactory results, it is wise to purchase annual drafts of rams from him. Adherence to this policy will quickly bear fruit, providing the flock is carefully culled and well and evenly fed.

Before selecting rams it is wise to carefully study the flock of ewes in order to determine their weaknesses, and then to choose sires which are particularly outstanding where the ewes are deficient in order to correct these faults.

Good rams also exert a powerful influence on the covering of the sheep. They will quickly put body and style into the fleece if, as before, feeding and culling are carefully attended to. With rams as cheap as they are to-day, there is no reason why so many farmers (and there are still many) should place on the market clips of characterless merino wool.

Unfortunately, since the rapid decline in commodity prices, the tendency among flock owners has been to economise by reducing the number of rams used or buying sheep of inferior quality. This may, temporarily, be a source of economy, but it will soon lead to very great direct loss, for, just as a well-husbanded flock will rapidly improve if mated to good rams, so will it quickly deteriorate if mated to inferior sheep. It should rather be the policy of sheep farmers to make the best of one of the few advantages that are offered by the present condition of economic affairs, by buying high class sheep while they are available at ridiculously low prices. When the wool market improves, ram prices will rise accordingly, so now is the time to "get in on the ground floor."

On 3rd and 4th October, the leading stud-breeders of the Great Southern districts are conducting a sale of high class rams at Katanning, and the breeders in the Midlands district are holding a similar sale at Moora on 6th October. These will be followed by the annual Royal Show sales on 12th and 13th October. These sales should be well attended as, not only do they provide many farmers with an opportunity of making their annual purchases, but also they have a great educational value in that they teach growers to assess relative values in sheep and display to them the type of sheep which they must strive to breed.

PATERSON'S CURSE.

(*Echium plantagineum*, Linn.)

C. A. Gardner, Government Botanist.

Paterson's Curse is a native of the Mediterranean Region and Western Europe, from where it has been introduced into other countries both accidentally and as an ornamental plant. Its common names are numerous. In Europe, where it is cultivated to some extent in gardens, it is commonly known as Viper's Bugloss, Echium being derived from the Greek Eches, meaning Viper. In South Australia it is referred to as "Salvation Jane" or "Blue Weed," while in this State it is also known as "Lady Campbell Weed."

The first record of this plant in Australia dates back to about 1895, when it was introduced as a garden flower to a place near Albury, in New South Wales, by a certain Paterson. It gradually spread until it encroached on a travelling stock reserve. After this the weed spread rapidly, particularly along the stock routes and in reserves, until it has now become widely distributed in the Eastern States.

Its local history is associated with the construction of the Great Southern Railway. Lady Campbell, wife of Sir Thomas Campbell, who was residing at the time not far from Broomehill, introduced this species as a garden plant, and from here it has become widespread, and is still known along parts of the Great Southern Railway as "Lady Campbell Weed."

Paterson's Curse has now been reported in this State from various places along the Great Southern Railway, Boyanup, Donnybrook, Brookhampton, and Bridgetown in the South-West, Wooroloo, Swan View, Darlington, and Guildford, and from Gingin, Mingenew, and Perenjori. It has not been officially recorded from the Eastern districts.

Around Broomehill, Kojonup, and Boyanup it occurs very extensively, often covering large areas. Certain areas in the Boyanup district are very badly affected, and on one farm, in particular, where the weed has been established for some time, it has taken possession of about 25 acres. Further North it is more sporadic, but there is always the possibility of its spreading, and if unchecked, becoming very common. The early growth, which takes place in winter, consists of a number of basal leaves which lie flat on the ground, thus smothering the more frail vegetation underneath. When these leaves die bare patches remain, and the productivity of the field is greatly reduced. The plant is annual, biennial, or sometimes almost perennial in habit, and thrives on rich moist soils. After stooling and spreading during the winter, flowering stems are produced in spring. Each stem bears a considerable number of striking violet flowers, the reproductive parts of which give rise to single-seeded nutlets, which are easily distributed.

As is the case with a number of other weeds when first found, it has been spared for sentimental reasons owing to its attractive flowers. This is certainly dangerous when the free seeding nature of the plant is considered and the manner in which it is spread by stock.

There are two objectionable features of Paterson's Curse. In cereal crops it is particularly troublesome in crowding out the growing crops, and interfering with harvesting operations. In pasture lands it crowds out more valuable annual

pasture crops, and considerably reduces the dry feed value of the pasture. It is not likely to prove as troublesome in good permanent pasture land since the more vigorous grasses, such as Couch and Paspalum, are able to compete with it, or even crowd it out.

PATERSON'S CURSE (*Echium plantagineum*, Linn.)

A.—Plant.
B.—Inflorescence and leaf.
C.—Flower and section of same (enlarged).
D.—Fruit (enlarged).

Paterson's Curse has some value as a fodder plant, but it must be emphasised that this quality is not one to make the plant a particularly desirable one. The plants are eaten by stock, when young. Where feed is scarce it may be quite useful, providing a succulent spring feed. The mature plants, however, are fibrous and harsh, and usually avoided by stock. Stock, however, will eat it if reduced to that extremity, but there is always a risk of the animals having digestive trouble. The weed has certainly received some praise from the drier areas of other States, hence the name of "Salvation Jane." Since these conditions do not obtain in our South-Western districts it is scarcely necessary to speak well of the weed on this account, and it should always be remembered that if other feed will grow, Paterson's Curse is an undesirable weed.

When the plant first appears it should be hand pulled and hoed, and a close watch kept of the area for further growth. Where it has become widely established, this method of eradication is not practicable, and heavy stocking or cultivation must be carried out. The plants are eaten, in their young stages of growth, by stock, and large numbers of animals should be placed on comparatively small areas at a time. This heavy grazing, repeated at intervals, should prove effective in controlling the weed. Stock grazed on Paterson's Curse, which is in seed, however, ingest the seeds which, being contained in nutlets, are not all digested, and are thus spread by the wandering animals. Another and efficient method of attack is cultivation which should be repeated when appreciable growth is made. This cultivation should commence in winter, prior to the formation of flowering stems, and in the following autumn, as early as the season permits, a vigorous smothering crop should be grown. The nature of this crop will vary for different districts, but subterranean and drooping flowered clovers make a good general base for this crop.

One point to be stressed is that the plants should not be allowed to produce flowers, for even if the flowers have just opened and the plants are pulled and thrown on the ground, seeds are likely to be formed. Unfortunately the weed burns badly, even when dry. The seeds retain their viability for a considerable number of years, and continue to germinate each year until the supply is exhausted. Thus, once the plant has become established and seeded, a careful watch must be kept for several years.

Hay, particularly clover hay, should not be obtained from affected areas, and care should be exercised when purchasing seed. Subterranean clover burr, in particular, should be avoided for this reason alone, if grown in areas where Paterson's Curse is prevalent. The nutlets can easily be eliminated from cleaned seed.

Description of Plant.

An annual or biennial herb of usually one or two and a-half feet, branching at the base with several erect stems, stout and hairy. Leaves mostly basal, the basal large and oval-lance-shaped, stalked, the upper leaves smaller, without stalks and heart-shaped at the base. Flowers violet, in long curved racemes, each flower subtended by a leaf-like bract. Calx deeply divided into five acute lobes, hairy with stiff white hairs. Corolla tubular, bell-shaped, about three times as long as the green calyx. The fruit consists of four small wrinkled nuts, which fall out of the base of the persistent calyx. The flowering season is September to November; the plant seeding about the same time, or into December.

TOXIC PARALYSIS OR BOTULISM.

Twenty-one Points for Attention.

1. Toxic paralysis is a disease which is prevalent in the agricultural areas during the summer months.

2. Horses are rarely affected, cattle and sheep to an enormous extent in some areas in Western Australia.

3. **AS NO CURE IS KNOWN TOXIC PARALYSIS MUST BE PREVENTED.**

4. The direct cause of this disease is a germ toxin or poison which is swallowed by stock and which is found in decomposing animal matter, bones, rabbit and other carcases, and in decaying vegetable matter like mouldy or damp hay.

5. Stock can therefore become affected if they develop an unnatural or depraved appetite and lick or eat contaminated bones or rabbit or other carcases (affecting generally sheep or cattle), or if they eat contaminated hay, etc. (affecting generally horses).

6. A depraved appetite is caused by a deficiency of one or more food constituents in the daily food supply.

7. The dry summer pasture in Western Australia contains insufficient nutriment to meet the maintenance requirements of wethers and store stock.

8. For milking cows, wet ewes and growing annimals, the deficiency in the summer grazing is much greater.

9. The natural difficulties in this connection have been intensified by the depredations of the rabbit pest.

10. Cereal stubbles, exclusive of shed grain, are entirely inadequate for the needs of stock in the summer.

11. A sheep cannot eat sufficient stubble to supply more than three-quarters of the energy or heat producing material, one-third of the protein, or one-sixth of the phosphate required by a full-grown ewe.

12. Half a pound of oats or 1 lb. of good hay daily to supplement the stubble would still supply insufficient protein and phosphate.

13. Sheep grazing solely on stubbles or dry natural feed are, therefore, most likely to develop a depraved appetite, followed by toxic paralysis, when contaminated material like rabbit carcases or bones are available.

14. The deficiencies in the summer grazing should be made good in order to prevent the depraved appetite and toxic paralysis.

15. Toxic paralysis has been prevented in many cases by feeding a phosphatic lick of satisfactory strength in sufficient amounts.

16. In other cases the trouble is due to insufficient nutriment generally. It is then necessary to supplement the natural feed with a ration of oats or lupins ½ to 1 lb., or hay 1 to 2 lbs. daily.

17. The standard dicalcic phosphatic lick recommended consists of:—

Dicalcic phosphate	45 parts.
Salt	40 parts.
Molasses	5 parts.
Water to condition	10 parts.

or—

Dicalcic concentrate	50 parts.
Salt	50 parts.

This lick contains 18 per cent. phosphoric acid (P_2O_5).

18. Dry cows on summer pasture require 5 ozs. dicalcic lick per day; milking cows require, in addition, 2 ozs. dicalcic lick for each gallon of milk produced.

19. Sheep on dry summer grazing require at least fourteen (14) pounds of this lick per hundred per week.

20. If much more than this is consumed an appetite for salt is indicated. In this case a lick consisting of—

Dicalcic concentrate	50 parts
Salt	100 parts

is recommended. This lick contains 10 per cent. phosphoric acid (P_2O_5).

21. Further information may be obtained from the Department of Agriculture, Perth.

THE COMPOSITION OF SOME COMMON WESTERN AUSTRALIAN STOCK FOODS.

Geo. L. Sutton, Director of Agriculture.

Because of the increasing attention which is being given by stockmen in Western Australia to the relative nutritive value of stock foods, Tables I. and II. hereunder, containing information relative to the composition and food value of stock foods in common use, have been prepared by Agricultural Advisers L. C. Snook, B.Sc., Agr., and G. L. Throssell, Dip. Agr., after consultation with other officers also interested in this work.

As further data is accumulated it may be necessary to amend some of the figures now given, but, as far as can be gauged from the details now available, the information in the table hereunder may be accepted as a good index of the composition and food value of the stock foods to which they refer.

In Table 1 will be found the percentage composition and the digestion co-efficients of the different stock foods. For those not familiar with such tables, it is necessary to point out that the composition of any food is not constant but varies as the result of many factors. The analyses selected and included are those, which after consideration of the information available, are regarded as being representative of the food to which they refer and as grown under local conditions. In the absence of local digestion trials to provide digestion co-efficients for the different foodstuffs, those obtained in other countries for the same or similar stock foods have been accepted and used.

In Table 2 will be found the percentage composition of the dry matter and its nutritive value calculated from its digestible nutrients. The production starch equivalent has been calculated according to the Kellner formula, in accordance with which the percentage availability of the fodders is a value "V" introduced by Kellner, and now generally adopted by British authorities. This "V" value is shown under the heading V. The nutritive ratio has been calculated according to the formula:—

(Digestible fat $\times$ 2.3 + Digestible Carbohydrates + Digestible Fibre) $\div$ Digestible Crude Protein.

TABLE 1.

Foodstuff.	Percentage Composition.								Digestive Co-efficients.				
	Dry Matter.	Crude Protein.	Crude Fat.	Nitrogen Free Extract.	Crude Fibre.	Total Ash.	P_2O_5.	CaO.	Crude Protein.	Crude Fat.	Nitrogen Free Extract.	Crude Fibre.	"V"
GRAINS AND THEIR BY-PRODUCTS—													
Barley (feed)	88	11·0	2·2	68·0	4·5	2·3	0·82	0·06	74	80	92	50	98
Lupins	86	29·5	6·2	36·2	11·2	2·9	...	...	80	80	90	57	88
Maize	87	9·9	4·4	69·2	2·2	1·3	0·63	0·03	74	93	94	57	100
Oats	88	9·0	5·0	58·5	11·5	4·0	0·93	0·16	78	80	80	25	95
Peas—Field	88	22·5	1·6	55·5	5·4	3·0	0·84	0·098	86	60	93	40	98
Wheat	88	11·3	2·0	71·0	2·3	1·5	0·70	0·048	80	70	90	40	95
Bran—Wheaten	88	16·0	2·0	58·0	8·0	4·0	1·87	0·057	80	70	70	30	80
Pollard—Wheaten	88	17·0	3·0	60·0	5·0	2·5	...	...	80	86	80	30	80
Linseed	93	24·2	36·5	22·9	5·5	3·9	1·4	...	85	95	83	70	96
Linseed Meal	88	30·0	4·0	40·0	8·4	5·6	1·70	0·51	85	95	83	70	96
Meat Meal (W.A.)	92	64·0	15·7	2·3	2·0	8·0	3·66	...	93	98	50	...	100
GREEN FODDERS—													
Green Lucerne—Bud Stage ...	20	5·0	0·8	8·4	3·0	2·8	...	...	75	50	75	70	80
Full Flower ...	25	4·75	1·0	11·25	5·0	3·0	0·19	...	75	40	70	40	74
Green Fodder Maize	22	1·9	0·6	13·0	5·3	1·2	0·11	...	60	75	75	65	82
Rape	14	2·8	0·8	5·7	3·5	1·2	...	...	89	49	92	87	87
Subterannean Clover—Young ...	18	4·3	0·3	8·7	3·15	1·5	0·252	0·18	80	60	80	80	92
Hay Stage	25	4·5	0·7	12·5	5·0	2·25	...	...	60	55	65	55	75
Mature ...	90	8·1	1·8	44·1	27·0	9·0	...	...	50	50	60	50	60
Sudan Grass—2ft. high ...	22	3·6	0·8	8·2	5·7	3·7	...	...	80	60	80	70	85
In Flower ...	40	4·7	0·6	17·0	13·9	3·8	...	...	65	60	75	60	80
Silage—Mixed Clovers and Grasses	25	3·5	1·0	10·5	7·5	2·5	0·14	...	60	70	60	60	70
DRY ROUGHAGES—													
Lucerne Hay	92	15·0	1·8	36·0	30·2	10·0	·54	1·95	90	39	72	43	57
Meadow Hay—Clovers and Grasses	88	9·0	2·0	41·6	29·0	6·4	0·41	...	60	55	65	55	70
Oaten and Wheaten Hay—Cut at Flowering stage	88	7·0	2·0	5·0	21·0	6·0	0·18	0·37	60	55	65	55	70
Wheat Straw (Stubble) ...	92	3·1	1·5	44·8	37·4	5·2	...	...	23	31	37	50	38
Oat Straw (Stubble)	89	3·6	2·4	41·3	36·3	5·4	...	...	28	39	51	60	43

TABLE 2.

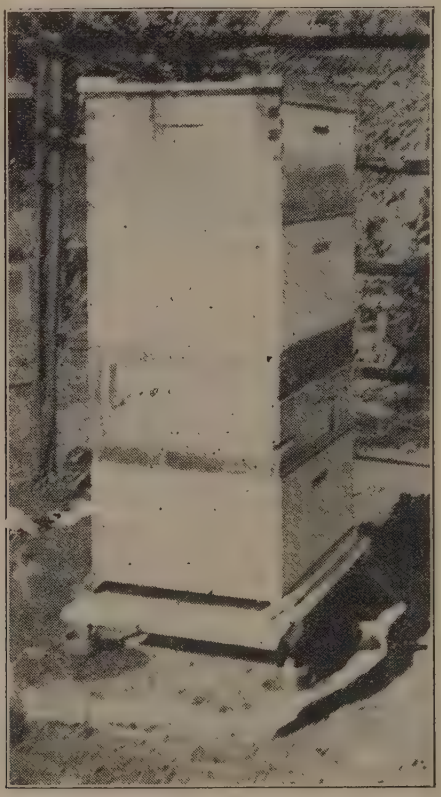
Foodstuff.	Composition of Dry Matter.							Digestible Nutrients in Dry Matter.					Nutritive Ratio 1:
	Crude Protein	Crude Fat.	Nitrogen Free Extract.	Crude Fibre	Total Ash.	P_2O_5.	CaO.	Digestible Crude Protein.	Production Starch Equivalent.	Total Ash.	P_2O_5.	CaO.	
GRAINS AND THEIR BY-PRODUCTS—													
Barley (feed)	12·5	2·5	77·3	5·1	2·6	0·93	0·07	9·3	85	2·6	0·93	0·07	8·4
Lupins	34·3	7·2	42·1	13·0	3·4	...	...	27·4	75	3·4	...	...	2·1
Maize	11·4	5·1	79·5	2·5	1·5	0·72	0·03	8·4	94	1·5	0·72	0·03	10·3
Oats	10·2	5·7	66·5	13·0	4·6	1·05	0·18	8·0	71	4·6	1·05	0·18	8·3
Peas—Field	25·6	1·8	63·0	6·2	3·4	0·95	0·11	22·0	84	3·4	0·95	0·11	2·9
Wheat	12·8	2·3	80·7	2·6	1·6	0·79	0·055	10·2	83	1·6	0·79	0·06	7·5
Bran—Wheaten	18·2	2·3	66·0	9·0	4·5	2·12	0·066	14·6	54	4·5	2·12	0·07	3·6
Pollard—Wheaten	19·3	3·4	68·2	5·7	3·4	...	...	15·5	80	3·4	...	...	5·6
Linseed	26·0	39·2	24·6	5·9	4·2	1·5	...	22·1	129	4·1	1·5	...	5·0
Linseed Meal	34·0	4·6	45·4	9·6	6·4	1·9	0·58	29·0	80	6·4	1·90	0·58	1·8
Meat Meal (W.A.)	70·0	17·0	2·5	2·2	8·7	3·94	...	65·0	100	8·7	4·0	...	0·62
GREEN FODDERS—													
Green Lucerns—Bud Stage ...	25·0	4·0	42·0	15·0	14·0	...	...	19·0	52	14·0	...	...	2·4
Full Flower ...	19·0	4·0	45·0	20·0	12·0	0·76	...	14·0	42	12·0	0·76	...	3·0
Green Fodder Maize	8·6	2·6	60·0	23·6	5·4	0·5	...	5·0	57	5·4	0·50	...	13·0
Rape	20·0	5·7	40·7	25·0	8·6	...	...	17·8	58	8·6	...	...	2·9
Subterannean Clover—Young ...	23·8	1·7	48·5	17·5	9·0	1·4	1·00	19·0	68	9·0	1·4	1·00	2·9
Hay Stage	18·0	3·0	50·0	20·0	9·0	...	...	10·8	44	9·0	0·6	...	4·4
Mature ...	9·0	2·0	49·0	30·0	10·0	...	...	4·5	30	10·0	0·4	...	10·0
Sudan Grass—2ft. high ...	16·4	3·7	37·4	25·9	16·6	...	...	13·1	54	16·6	...	...	2·6
In Flower ...	11·8	1·4	42·5	34·7	9·6	...	...	7·7	49	9·6	...	...	7·0
Silage—Mixed Clovers and Grasses	14·0	4·0	42·0	30·0	10·0	0·56	...	8·4	40	10·0	0·56	...	6·0
DRY ROUGHAGES—													
Lucerne Hay	16·3	2·0	39·1	32·8	10·9	·59	2·11	11·41	31	10·9	0·59	2·11	3·9
Meadow Hay—Clovers and Grasses	10·2	2·3	47·2	33·0	7·3	0·46	...	6·1	40	7·3	0·46	...	8·6
Oaten and Wheaten Hay—Cut at Flowering stage	8·0	2·3	59·0	23·9	6·8	0·20	0·42	4·8	41	6·0	0·20	0·42	11·0
Wheat Straw (Stubble) ...	3·4	1·6	48·7	40·7	5·7	...	...	0·8	15	5·7	...	...	49·4
Oat Straw (Stubble)	4·0	2·7	46·4	40·8	6·1	...	...	1·1	22	6·1	...	...	46·0

CARNIOLAN BEES.

H. WILLOUGHBY LANCE,
Apiculturist.

Since writing in the "Journal" in June, 1931, on Carniolan Bees, further experience has been gained with them, and all that has been said in their favour has been maintained, and they are rapidly increasing in favour and popularity, so much so that the Department could not fulfil all the orders for queens last season.

The old prejudice against them, that they were great swarmers, has been proved wrong. We can only speak for the strain that we are handling. Other strains may be different, just as Italian strains vary. One instance is given. Messrs. McNamara Bros., of York, who are Carnaising their apiaries as rapidly as



possible, left one of their out apiaries unvisited longer than usual early last season, as they did not think there was much honey coming in. When they did inspect it, they found that there had been a honey flow and half the colonies had swarmed. All of these were Italians. The Carniolans had not swarmed, but were storing honey in the brood chamber.

Other beekeepers are continually writing in saying how satisfied they are with the Carniolans, and the following are a few extracts from letters:—

A beekeeper at Denmark wrote—"I must say I am more than satisfied with the Carni queen you sent me."

A beekeeper at Narembeen, writing on November 18th, 1932, said: "I must tell you that as regards Carniolan bees, they are jolly hard to beat. I had a look at mine on the 9th and got a surprise to see ten full depth combs filled with honey and sealing from the top bar. This colony has built up very strongly since I purchased it on the 24th September. At present I have made it into three stories and all the bees cannot get in at night when they all return." (Note this is less than two months.) "The last Carniolan queen I received from you has laid hot and strong since I have had her. In fact, I am sure she is a better queen than the other. I made a test to see what she did lay and she filled a comb in three and a half days, in which I counted 7,290 cells. The other hives of bush bees are fairly strong, but very little honey in store. On the test between the two lots, I am satisfied Carniolans will do me, and next year I will have more."

On February 1st he wrote again:—"Beekeeping is going at full swing up here. I have been increasing a few more colonies of Carnis by two queens which I was successful in breeding. I took the brood from one hive and put it in a queenless hive of bush bees, which had no eggs or brood whatever. They built five good queen cells on the combs, but I only had luck in securing two. The queens were mated with drones from the first colony of Carnis I got from you, and have been laying for four weeks now, and the bees produced from the queens are just the same as the others. I am enclosing herewith photo. of the hive of Carni bees which I received from you in September, 1932, as a nucleus."

In February, 1933, we visited a beekeeper at Pemberton, to whom we had supplied a nucleus in September, and found that the nucleus had increased to two hives, one being 2 storey, 10 frames; and one 3 storey, 10 frames.

As regards their gentleness, we seldom use a veil at Rottnest, even when getting down to the brood chamber of a 4-storey hive.

THE CLEANSING OF MILKING MACHINES.

M. Cullity, Agricultural Adviser, Dairy Branch.

Cheaper methods of clearing, the use of Subterranean clover and the practice of top-dressing have made possible the development, on a rapid scale, of our pasture areas. As a consequence the carrying capacity of most farms has increased, and, with the further expansion of the dairying industry the tendency will be to a greater extent towards larger herds. These have been increasing gradually for some time and where the properties are capable of carrying more stock than can be handled easily by the labour normally available, the owner has to decide, either to increase his herd of milch cows, or to buy dry stock for fattening. Should the decision be to increase the herd, further labour must be employed or else a milking machine purchased. Usually it will prove more economical to purchase a machine than to employ extra men solely because of the necessity of having additional assistance at milking time. That this is so is shown conclusively by a survey carried out in U.S.A. where 1,160 users of machines were queried, with the following results:—

(1) Over 34 per cent. said milking machines saved more than 2 hours per day.

(2) Over 14 per cent. said they saved 50 per cent. in time and labour.

(3) Over 25 per cent. said they saved the entire time of one man.

Further in a survey of dairy farms in the Murray Valley of Victoria and South Australia in 1929 it was shown that with small herds the labour income was lower with machines milking than with hand milking. With the larger herds, however, considerably higher labour incomes were received where machines were used. It may be assumed therefore that the larger the herd, the great the profit will be, on installing a machine. The decision to purchase a machine will be assisted in many cases by the knowledge that the care of a machine is not onerous. Unfortunately the point is not appreciated that, although some efficient methods of caring for a machine may be easy, all easy methods may not be equally successful. Further, many of the so-called easy methods are undoubtedly expensive, in as much, as the cash losses, as a result of inferior cream, may far outweigh the value of the time saved in the cleaning. Generally, it may be stated, that the farmer using a machine is genuine in his desire to produce a sanitary product, and his failure to achieve this object is often due to a misconception of the ideals of dairy sanitation. Often great faith is held in costly cleansing preparations and much expense and worry are incurred uselessly in trying to improve the product. A cleansing material of some nature is, of course, necessary for removing greasy deposits left by the milk in the rubbers and pipe lines, and for this purpose nothing has yet been evolved which would do this work more thoroughly or more cheaply than a solution of soda. Precautions, however, are necessary in using a soda solution, as if any of this obtains access to the milk the result is very damaging. Further, if the solution is left in contact with tinware, corrosion will occur. The precaution against this is obvious and simple. A thorough rinsing following the soda solution will obviate any danger. What is usually overlooked, however, is the bacterial contamination that takes place throughout the teat-cups, rubbers and pipe lines. These may look clean and smell clean but still have a very harmful effect on the milk produced. Usually an average of 12 hours elapses between milkings and the atmosphere of the pipe lines, etc., is no more pure than the surrounding air in the shed and yards. Where brushes and scrapers are used in cleaning, the rubbers and teat-cups become scoured and scored and occasionally receive deep cuts. These marks prove effective lodging places for accumulations of dirt and grease, which become decomposed by bacterial action. These act as contaminating centres by pouring direct to the milk stream quantities of bacteria, and break down products from the accumulated dirt which detract immediately from quality, or which, if not developed sufficiently to be detected on the grading floor of the factory, may cause great harm to the keeping quality of the butter manufactured.

In view of the foregoing, investigations carried out at the instance of the Royal Commission on the metropolitan milk supply, 1925, are exceedingly interesting. Investigations were carried out to compare the results of hand-milking with those of machine-milking, and to determine the importance of various factors involved in the production of whole milk. The following table summarises the data collected and will give some idea of the extreme difficulty experienced in obtaining high quality milk with the use of milking machines unless operated with more than ordinary care.

	Organisms per c.c.	Bacillus coli per c.c.
A. Hand-milking dairies (ordinary conditions) ..	52,120	135
B. Hand-milking dairies (special precautions) ..	3,900	40
C. Hand-milking dairies (private cows)	900	—
D. Machine-milking dairies (ordinary conditions) ..	694,504	743
E. Machine-milking dairies (special conditions) ..	60,000	197
F. Machine-milking dairies (Investigation National Institute of Dairying, Reading	1,000	—

(A) Hand-milking dairies under ordinary conditions. Dairies were visited during milking, which was carried out in the dairyman's usual method.

(B) Simple alterations were made to dairyman's routine and samples were taken at the point of delivery to customers. The precautions taken were only reasonable cleanliness on the part of the milker, washing hands, etc., the washing of udders, the rejection of the first jets from each quarter, the scalding of all utensils *before use*, and the use of ice tubes in milk to be stored over night.

(C) Milk from private cows. Absence of dust, etc., and the easier achievement of cleanliness in general. Only simple precautions were taken. The udder and teats were wiped with wet and then dry cloths. The flank was wiped with a dry cloth. The first jets from each teat were rejected.

(D) Samples were taken in a similar manner to A, from milking machine dairies.

(E) Represents samples taken from machines cared for under better than average conditions. Attempts were made, unsuccessfully, at two dairies to improve the counts.

The methods employed at the two dairies mentioned were as under:—

1. "After each milking, cold water, followed by hot water and soda, followed by hot water, was drawn through the machine. The movable parts were placed in the milk room until morning, two or three times a week the cups were completely dismantled and cleaned with hot water and brushes."

2. "After one milking cold and then boiling water was pumped through, and the parts were placed in the milk room. After the next milking, cold and then boiling water was pumped through, and the machine was completely dismantled, washed with brushes, hot water and soda, and then immersed in ordinary cold water until assembling for next milking. The washing process was very thoroughly done."

It is possible that, had the altered methods been used for several days before taking samples, other results would have been obtained. Once teat-cups and rubbers begin to absorb dirt and grease they cannot be cleaned up satisfactorily in one operation. This was definitely shown during the same investigation. At one dairy where the machine had not been dismantled for some days, bacterial counts of 947,000 total and thousands of Coliform bacteria were obtained. The machine was dismantled and was treated by special methods. The parts were scrubbed in water at 170 deg. F. for several minutes. The buckets were well washed with water at 200 deg. F. At the following milking, counts as under were obtained:—

270,400 total 238 Coliform Bacteria.
150,080 total 904 Coliform Bacteria.

This illustrates the point that when a machine becomes a serious contaminating agent, it is extremely difficult to bring it back to a sanitary condition within a short space of time. The writer has seen this demonstrated on many occasions, when milking machines were responsible for the cream produced being of inferior grade. Usually a period of days elapses under improved methods of cleaning before a choice cream can be produced. In one case where the vacuum system was badly contaminated, a full fortnight elapsed before choice cream was obtained.

(F) See later, under reference to vacuum system.

It will be noted that in the methods used in the investigations referred to, brushes played an important part. It is accepted that the use of brushes on rubber ware will cause the surfaces to lose their fine smooth texture and to become pitted. When used carelessly the surfaces may even become cut. It seems probable therefore that the rubber-ware on the machines tested were in a condition whereby contamination was continuous irrespective of the method used. Possibly

if new rubbers had been fitted to the machines and washed for several days under the altered conditions improved counts would have been obtained. However, new rubbers and teat-cups do not necessarily mean no contamination, as one sample during the investigation, taken from a machine which had been in use for 10 days only, showed a count of 624,000 total and 1,888 coliform bacteria. This should demonstrate the rapidity with which improper methods of cleaning can do great harm. More recent work in milking machines, however, has shown that a sanitary product can be obtained easily, while at the same time the life of the teat-cups and rubber-ware can be lengthened. In the method to be described no brushes or

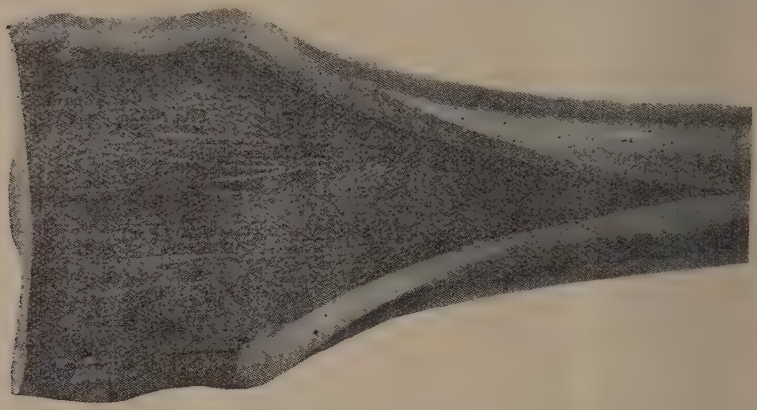


Fig. 1.—Long Milk-rubber after Twelve Months' Use and cleaning daily with Boiling Water, Washing-soda, and the use of a Brush and Scraper.
Note the scored inner surface of the tube.
(*By courtesy N.Z. Dept. Agric.*)

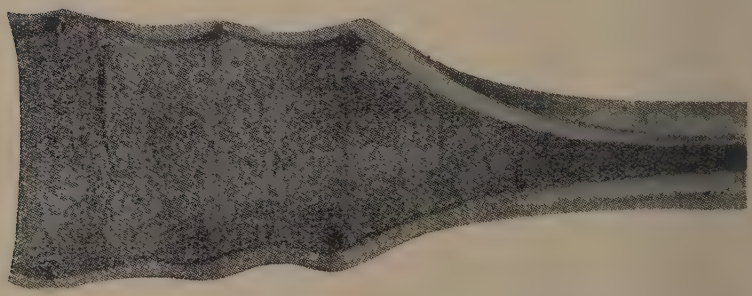


Fig. 2.—Claw-tube Rubber from the same Machine as Milk-tube in Fig. 1
The Indentations indicate effect of Lodgment of Grease.
(*By courtesy N.Z. Dept. Agric.*)

scrapers except for the outside of the teat-cups and the buckets, are required. The solution used removes all grease readily and causes the surface of the rubbers to become glazed. Naturally this renders the adherence of dirt difficult and reduces direct contamination to a minimum. Caustic soda is used as the cleansing agent, and if instructions are followed fully there can be no danger to the metal parts of the machine or the milk. Thorough rinsing will remove any trace of the solution.

This system is being used largely in New Zealand, Victoria, and New South Wales, with great success and has been described briefly by J. W. Smith in the New Zealand Journal of Agriculture. The procedure is as under:—

1. Before milking, draw cold water through all milk tubes and the releaser, so as to prevent the adhesion of milk to the pipes, etc.

2. Immediately after milking wash all dirt off the outside of the teat-cups and rubbers, then draw through each set of teat-cups sufficient cold (or preferably warm) water to flush out the milk system. When drawing the water through the set farthest from the releaser, insert a ball of horse-hair in the end of the milk pipe to cause it to travel through to the releaser with the water.

3. Next draw through *each set* of teat-cups *not less than one gallon of boiling water* to which caustic soda has been added at the rate of *not less than* 1 *to* 1½ *tablespoonsful per* 4 *gallons of boiling water*. Distribute the solution as evenly as possible through each set of teat-cups.

4. Immediately follow by flushing out the caustic soda solution with 2 gallons of hot water or 1 gallon of *boiling water* for each set of teat cups; the flushing with boiling water helps to dry the rubbers and leaves the milk system dry and sweet.

5. Then remove or open the plug or flap from the releaser pipe to allow of free circulation of air.

6. Next *clean the vacuum system* in the same manner as the milk system by drawing through first the caustic soda solution, and next the boiling water which has been circulated through the milk system. Pay particular attention to the cleaning of the pipe connecting the releaser to the vacuum tank, by flooding the releaser to cause the water to travel through to the vacuum tank. This is important.

7. The engine can now be stopped. *Disconnect the two long rubbers* from down-pipe and teat-cups and hang in a clean, airy place out of the sun

8. Next disconnect the releaser, wash, rinse, and place in a clean dry sunny place, then disconnect the top or bottom half of the vacuum tank and treat in a similar manner. *To be successful these operations must be carried out daily.* This does not dispense with the necessity of dismantling the machine as often as possible so that joints and crevices may be examined and treated.

The method described above follows directly the general directions given for the cleansing of dairy equipment, *i.e.* (a) the removal of albumen and curd by rinsing in luke warm or warm water; (b) a thorough washing and scrubbing in hot water with some cleansing agent; (c) sterilisation. To be successful this method must be used daily. All greasy deposits are instantly removed by the caustic soda solution, and this is in its turn removed by the boiling water. It does not do away with the necessity of dismantling the teat-cups, etc., as often as possible and to give a complete overhaul so that crevices and joints may not become a source of contamination. With this method, in a short time, the interior surfaces of the rubber tubes and teat-cups become coated with a glass-like substance which reduces the possibility of grease and dirt lodging thereon. The discarding of brushes, etc., means that scoring and cutting is prevented, and the rubbers enjoy a much longer life.

The most neglected part in many machines is the vacuum system. From this, when not kept in order, a fine spray of bacteria-laden moisture is continually being poured into the milk. On a casual examination it often appears difficult to realise how this contamination can come about. Leaks in teat-cups, spray drawn back

from the releaser, the condensation from water vapour given up from the warm milk, cause the lodging of water in system: if this is not removed the multiplication of bacteria takes place and portion of this contaminating fluid is mixed with the whirling atmosphere as spray in the system at succeeding milkings.

Trials carried out by the National Institute of Dairying, Reading, England, show the importance of proper care of this portion of the machine. Two milking machines in common use were tried. One was washed in the system suggested by the makers, and parts of the other in contact with the milk, sterilised. It was found that variable results were obtained, but sometimes good counts were followed soon after by very bad results; investigations of points which were thought might have an influence, such as, more thorough cleansing, the quality of air drawn into the receiver when the teat-cups were removed from one cow to another, gave no results which would account for the large variation being obtained. However, when the vacuum system was examined it was found that water collecting in the pipe

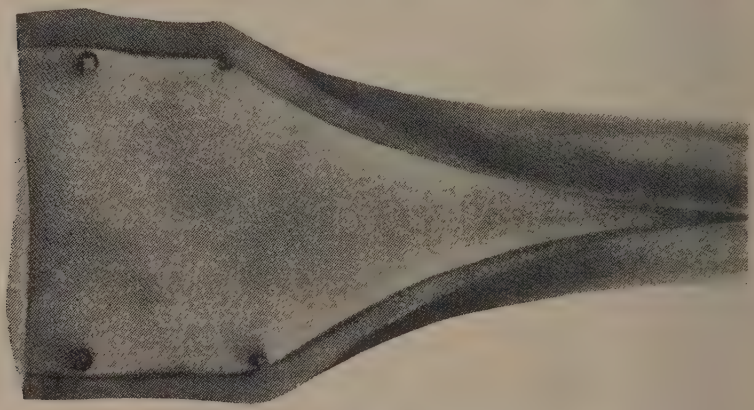


Fig. 3.—Long Milk-rubber after Two Seasons' Use and cleaning daily by the Caustic-soda-and-boiling-water Method.
(*By courtesy N.Z. Dept. Agric.*)

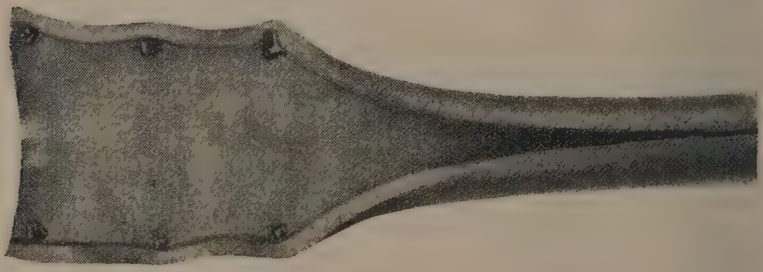


Fig. 4.—Claw-tube Rubber from the same Machine as Milk-tube in Fig. 3.
(*By courtesy N.Z. Dept. Agric.*)

line was heavily laden with bacteria. That this water was reaching the milk was then proved. Attempts were then made successfully to obviate all possibility of this occurring. An immediate improvement was noted in the bacterial counts of each machine. Those obtained by the sterilised outfit were particularly good: nearly

70 per cent. of the samples showing under 1,000 per c.c. The improvement of the other machine was also remarkable, although a small number of samples still showed very large counts, particularly during warm weather. The improvements found necessary by this investigation are nearly all standard in modern machines, e.g., the sloping vacuum line, vacuum supply taps taken off from the top of the pipe line, etc., etc. However, the mode of operation adopted by the farmer is not standard. Perhaps the most important suggestion made in the actual operation of the machines was to draw air through the system with all taps open for three minutes before and three minutes after each milking; this having the effect of drying out all moisture in the pipes. The necessity for keeping the vacuum system in a perfectly clean condition is therefore obvious. Section 6 of the instructions give a definite routine for carrying out this work. This should not under any circumstances be neglected.

Generally, the main features to bear in mind are: (1) use cold water to remove milk so that greasy deposits are avoided; (2) boiling water both for the soda solution and for the final rinsing. This in itself, apart from visible cleansing, will kill many germs and will heat up the machine to a temperature at which it will dry out completely. Wetness continuing on a dairy utensil for any length of time after washing, denotes definitely that the work has not been carried out efficiently. Information on the sterilising of separator parts, buckets in a manner suitable for adoption on farms at a small cost, may be found in the Journal of Agriculture, W.A., December, 1931. "The Cleansing of Dairy Utensils" by G. K. Baron-Hay; (3) store teat-cups and rubber tubes in clean atmosphere out of the sun, bearing in mind always that the atmosphere of a cowyard is not a clean one, and therefore there is a necessity to keep all parts which are removable in a purer air; (4) precautions should also be taken to see that contamination does not occur again before milking. The use of boiling water throughout the machines prior to milking and then cooling it again before milk is actually drawn will also help to hold the cost of the milk produced at a minimum.

Occasionally, more particularly where rubbers have been washed under another system and then a change is made over to caustic washings, complaints are heard that the rubbers commence to soften, and that they remain greasy. This usually occurs either at the point of junction of two lines, *e.g.*, where the long rubber fits on to a downpipe or where the interior of the rubbers are badly scored. It is the result of the soda solution gaining access to the bottom of the cuts or between the rubber and a metal pipe where a rinsing will not remove it. However, this does not occur on new rubbers on which brushes or scrapers have not been used. If the rubber tubes are not left connected up to the pipe line between milkings, the soda solution will not be able to do any damage.

The method has been used with success under Western Australian conditions, and the farmers who have used it have no hesitation in recommending it. One farmer who adopted this method writes:—"For cleanliness, effectiveness, quickness, and simplicity, this method is on its own." This farmer also stresses the point of using boiling water. He says further, "I find one never need have any fear of second-grade when using this method. I have been using a milking machine now for four years and have tried every known and unknown method of cleaning with all sorts of results, never getting much satisfaction, but a lot of work and worry, until you advised me of this method. The season before we cleaned the machine in the old way and I would not like to tell you of the results. It was awful. In one month we got 50 per cent. second-grade and that was not all." Other farmers using the method are also enthusiastic in praising its advantages, having in some cases almost completed the second year of its practise.

VINE PRUNING.

By H. K. Johns, Viticulturist.

"The use of the grape as a food preceded the making of wine. Primitive man, who lived by the chase and on wild fruits, gathered and ate with relish the grapes of the wild vines long before he discovered that he could make a joyous beverage out of them. As time rolled on and life became more settled, he took in the grape vine from the wilderness and gave it cultivation. Then, perhaps, began the selection of the finest and best flavoured grapes, and, presently, the propagation of strains. Left to itself, deprived of man's ceaseless, thoughtful care, the grape vine would revert speedily, helplessly, to the status of its wild progenitor."—(*Extract from "Wine Lands of the World."*)

Therefore, to prune intelligently, many aspects have to be taken into consideration—the age, size, condition of the plant, the location, soil, climate, variety (whether it requires short or long pruning), the principles governing its life, and other features of its environment. Of all fruit-bearing plants, the grape vine is one that requires careful pruning, and like all other fruiting plants, it responds to pruning, and the quality of fruit is improved by it. Pruning has one or more of the following objects:—Modification of shape and habit of the plant, removal, renewal, promotion, or retarding parts of the plant, increase or decrease in size and quantity of the fruit, also training to simplify cultivation, spraying, and the harvesting of the grape crop.

The time for pruning depends on the season's conditions. The only safe rule is that vineyards may be pruned as soon as the vines are dormant. If pruned too soon, the plants will be weakened and new growth will commence early; then, if a frost visitation is recorded, the young growing shoots will be destroyed, with loss of fruitful shoots. Early pruning will cause the vines to start early in the spring, while late pruning will considerably delay the starting of the buds. Generally, in this State, pruning commences the month of June and is completed by the end of August.

Vine cuttings for propagation may be prepared at any time after vines have become dormant, when cuttings can be selected from the parent plant. They should range from 12 to 18 inches and should always be made from young matured wood and preferably from medium-sized, short jointed wood growths arising from spurs or canes (rods) of previous season's growth. To make cuttings, cut close below the lower bud, the cut to be square across, and leave about an inch of wood above the upper bud or eye.

Illustration No. 1.

Each cutting should have the buds removed from the base end upwards, leaving the top two buds intact for production of growth. The reason for elimination of lower buds is to prevent entrance of dry rot, or any other attack such as white

ants, which may occur from the decomposing of the buds under ground. Soon after the commencement of the rise of sap and following growth, callousing will heal over all cuts, resulting in the trunk under ground being clean and well barked throughout. Cuttings should be tied in convenient-sized bundles, all buds pointing the same way. The bundles should then be buried in trenches with butt end up and covered with about six inches of soil. Inverting the bundles causes the butts to callous while the tops remain dormant, and the cuttings are ready to throw out a rooting system soon after planting in nursery or permanent position. If, on the other hand, they are heeled in with buds upwards, they often commence growth prior to developing root growth to support them.

When the ground has become warm enough, or in the early spring—August,—plant the cuttings in well, deeply worked soil. If in nursery, set each cutting at such a depth that only the upper two buds are just above surface level, spacing them about two to four inches apart with about three feet between rows. When selecting land for propagating cuttings, it is advisable, if possible, to have the sets in a position that can be irrigated with at least three or more waterings during the summer months. Also the soil should be kept well stirred with the hoe and cultivator to keep it mellow and as moist as possible. The principle involved is to create a good rooting and head growth the first year prior to planting in permanent position.

A description of the parts of the vine is necessary before the subject of pruning is considered, as per illustrations Nos. 2, 3, 4, and 5.

No. 2.—Photograph of 10-year-old Gordo Blanco Muscatel grown in the Swan Valley, before pruning.

(1) Main trunk or body of vine.

(2) Crown of vine formed at suitable commercial height for trellising.

(3) Main arms and permanent branches, which are of mature wood of several years old.

(4) Secondary arms which arise from the main arms and permanent branches.

(5) Canes of seasonal growth; when young, called "green shorts."

(6) Laterals which grow from canes in the form of seasonal secondary shoots.

(7) Water shoots which have sprouted from main trunk of vine.

No. 3.—Photograph of No. 2 after pruning.

(1) Main trunk or body of vine.

(2) Crown.

(3) Main arms.

(4) Secondary arms.

(5) Spurs.

The system adopted in the pruning of this vine, Gordo Blanco Muscatel, is termed spur pruning along the main arm or cordon, spurs being pruned to one clear bud. Generally growers in the Swan Valley shorten back the spurs to the basal bud with the object of lightening the crop and increasing quality. This variety of vine is a prolific bearer.

Illustration No. 2.

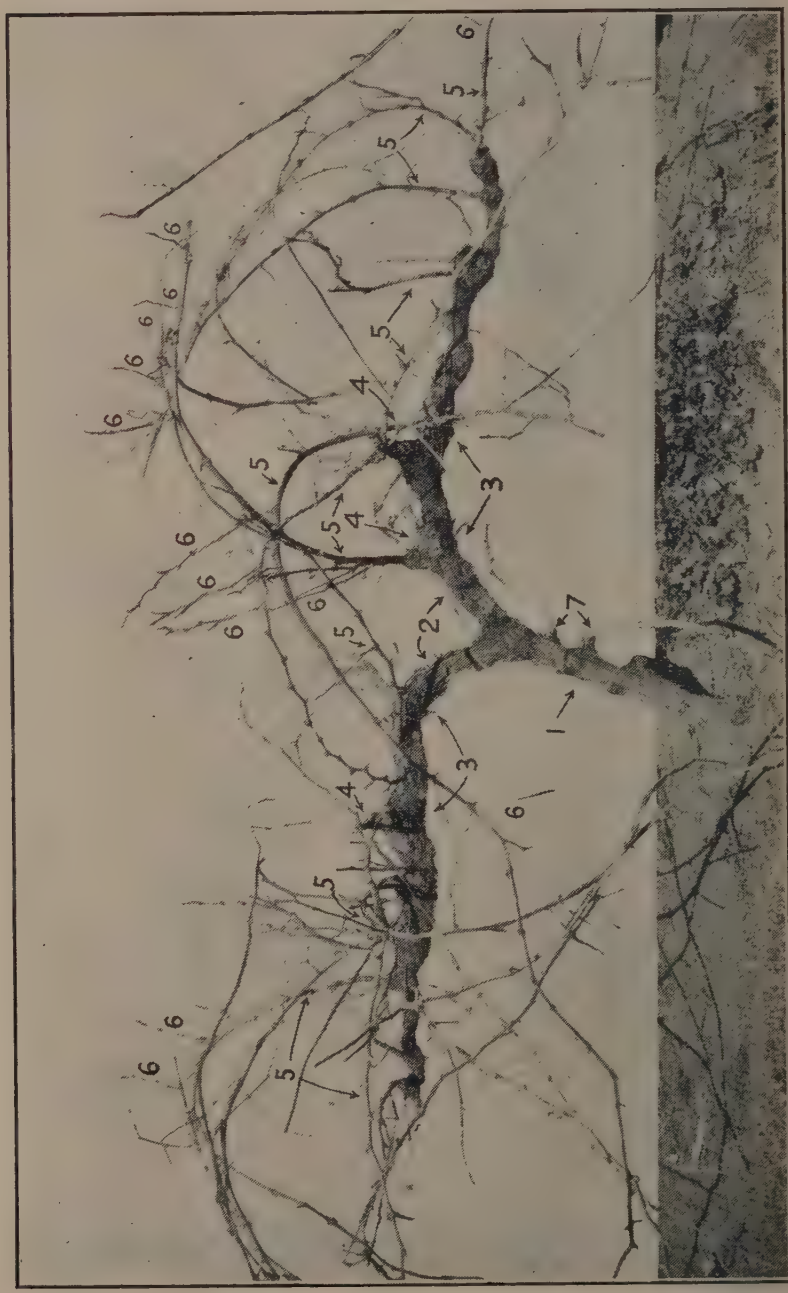


Illustration No. 3.

Illustration No. 3A.

No. 3A.—Showing crown, and portion of main arms, with subsidiary arms growing horizontally from main arms which carried the fruiting spurs, and is pruned to two distinct eyes on each fruiting spur. The variety of vine is Zante Currant.

Illustration No. 4.

No. 4.—Shows water shoots growing from main stem or body of vine. These should be pruned closely by the pruner, as shown in illustration No. 3.

Illustration No. 5.

No. 5.—Suckers which shoot from under the ground. The earth should be removed and the suckers cleanly removed by the pruner, as they are of no value, and, if allowed to exist, would rob the general growth of the parent stock.

Illustration No. 6.

No. 6.—This is a sketch of a grape vine after one year's growth in nursery, and the markings indicate the pruning of roots before planting, also pruning of top portion of vine to two distinct buds. Usually no training is given the first year after planting in a permanent position.

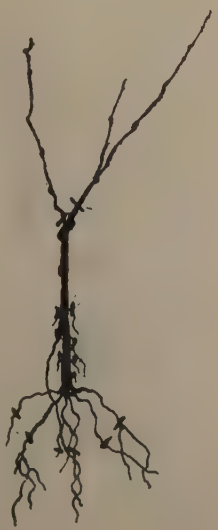


Illustration No. 7.

No. 7.—A vine pruned after the first year in the vineyard. The most upright growth is selected and pruned to two distinct buds.

Illustrations Nos. 8 and 9.

No. 8.—This shows the growth of the vine following pruning, as in illustration No. 7. Although the vine in No. 7 was pruned to two distinct buds, only one was allowed to grow; all other young shoots have been removed during early growth, preferably when not more than six inches long. This concentrates all the force of growth of the plant into the cane which is to become the main trunk or body of the vine. Care must be taken to stake and tie the growth until it reaches the required height for formation of crown. This care is necessary as a protection against winds, and is also essential for straightness of the main trunk. When the shoot has grown to about nine to ten inches above the height required for formation of crown of vine, the terminal growth should be pinched as marked "X" in illustration (No. 8). This treatment will cause laterals to grow where desired to form main arms for shaping and construction for the following season, as will be noticed in illustration No. 9, showing same vine after pruning.

Root Treatment.—A number of roots grow on many vine horizontals from the main trunk of vine just under the surface, while others grow deeper and of a straight downward growth. Those roots which stay near the surface of the soil

will sooner or later suffer during a long spell of hot weather, as the vine during that period has a very heavy task to perform, that is, to propagate growth in foliage and wood, also mature and ripen the fruit. Therefore it is necessary that during the second and third year all young planted vines should have the plant dug round to a depth of not less than six inches and all roots which have developed from the main trunk of vine to depth mentioned should be cut off close to the main stem. This will help to stabilise and develop the lower rooting system, and facilitate deep cultivation, which is necessary for the first ploughing during the winter months, without injury to the vine. It is essential that young vines should be properly cared for during their period of training and formation, as the early years of growth and treatment given the vines during that term largely determine the profit and good working to be derived from them.

There are two distinct methods of pruning—spur and rod pruning—and the two methods are applied individually or in combination, according to the habit of the growth of the vine. A rule that is to be remembered is that all vines bear fruit on the new wood, but, with most varieties, bearing wood only grows from wood of the previous year's growth. Vigorous growths sometimes grow from the old wood or main arms of the vine, and are called "water shoots," and do not produce grapes in the first season, so it is a safe rule for an amateur pruner to cut water shoots away. They should only be left in case of improving the shape of the vine. Some vines produce the fruit-bearing buds at the base of their canes, whilst in the vigorous growing varieties their fruit-bearing buds are situated well along the canes; therefore we find it necessary to spur prune and rod prune.

In pruning, selected fruit-bearing canes are cut back to spurs and rods. A spur is cut back generally to two clear buds, but the number of spurs to be left on each vine is to the judgment of the pruner, as he has to consider the variety and vigour of the plant. Spurs should be from four inches to eight inches apart, the strongest and most matured canes to be used, and on no account leave a cluster of spurs. In leaving too many spurs, the vines may bear too many and too small grapes. To find the medium between these extremes is always a great object and study to which the grower should devote his attention. If more than two eyes are left, the lower eyes may not develop, and the only thing attained by such pruning is to increase the size of the head and length of secondary arms, and thus place the leaves and grapes farther away from the main centre of the vine; also the vine and grapes will suffer damage from the implements during cultivation. In pruning the spurs, the cut should be made about midway along the internode, or well above the second bud, and not so close to it that it will be injured and dry out. A rod is actually a fruit-bearing cane cut back, leaving six buds upwards to one dozen to be suppressed the following year and a replacement to be laid down where vines grow strong and vigorous, and the variety is one that produces its fruit-bearing buds well along the canes. More wood is to be left, but there is a danger or at least a disadvantage in pruning either too short or too long, and in leaving too many spurs or rods. On leaving too many eyes, the shape of the vine is changed and becomes elongated, or even seriously injured. Definite direction of pruning cannot be applied to every locality or to every vine, as soils, variety, and climate are not all alike; therefore the methods of pruning have to be modified.

Illustration No. 10.

No. 10.—Vine before pruning, trained under the Goblet, or otherwise known as the Gooseberry-bush system. It is the simplest and cheapest method of pruning and training vines, and is in vogue in most commercial wine-growing vineyards, and the method also facilitates cultivation. An ordinary vine at about five years old consists of a trunk from which spring four or five arms; arising from them are the spurs from which the canes grow and carry the fruit.

Illustration No. 11.

No. 11.—The same vine pruned to the Basket-handle system, which embodies the spur and rod pruning in combination. The rods are interwoven; the principle involved is the rods to carry the fruit for the ensuing season, and at the next pruning season they are suppressed by the pruner and replaced by canes or rods growth arising from the spurs.

Illustration No. 12.

No. 12.—Vine pruned to the Goblet or Gooseberry-bush system. The spurs of last season are cut off just outside the inner canes, which in turn are cut back to spurs, carrying two distinct eyes or buds. The pruning each winter is to create a promotion of a regular system of spur renewal. As the vine becomes older and more vigorous, it will stand more cropping, and then more spurs are left to increase the yielding capacity of the vine. The head of the vine should be kept well balanced in shape, and as time elapses the arms of the respective spurs are renewed, and new arms and spurs are grown.

(To be continued.)

COW PEAS.

(Dolichos sinensis.)

G. K. Baron-Hay, Superintendent of Dairying.

In view of the particularly unfavourable season now being experienced, mitigating against the rapid growth of pasture, it is almost certain that the quantity of herbage cut and conserved as silage this season will be inadequate for the requirements of dairy stock.

The special value of subterranean clover silage has been that this food is succulent and, moreover, is a high protein-containing fodder. This latter quality is not possessed by the plants usually grown as summer fodders, such as maize, sudan grass, sorghums, etc. The special need is therefore for a summer-growing legume, and the writer believes that of various plants tried out during the last few years in this State, cow peas are by far the most promising.

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The cow pea, which is in reality a bean, is indigenous to tropical regions and has been cultivated in Africa and Asia for human food for many centuries. It is now commonly grown for soiling, pasturage, green feed, hay and ensilage for feeding to all kinds of stock, and as a soil improving crop. The seed can be utilised for human or stock food.

Climate and Soil.

Under suitable climatic conditions, which are somewhat similar to those required for the growing of maize, heavy yields of succulent fodder can be obtained

and grazed or preferably used in conjunction with maize, sorghum, or elephant grass as a green feed.

Being of tropical origin, cow peas thrive best under warm moist conditions, and at no stage of growth are they resistant to frosts or extreme cold weather. However, growth will continue throughout the summer until checked by the approach of winter. They are more drought resistant than maize, provided the ground is in good condition and the soil well cultivated between the rows.

Cow peas, like most crops, do best on good soils, but are not exacting as regards the soil conditions and will thrive on practically all classes of summer moist soils or ground where irrigation water can be supplied, but for success it is essential that the soil be well drained and the land thoroughly prepared. Generally speaking, cow peas do not produce an abundance of green material on the poorer soils but tend to produce heavier yields of seed. When grown for green forage, therefore, a previous application of farmyard manure greatly increases the weight of the resultant crop.

Preparation of Land.

If it is intended to grow cow peas alone, the soil should be prepared in a similar manner to that adopted for maize, namely, by ploughing to a depth of not less than 5 inches, and if possible, the area should be fallowed in the autumn and reploughed in the spring. After ploughing, the land should be brought to a fine tilth by the use of disc harrows, roller, and ordinary spike harrows. No difficulty will be experienced in obtaining a good stand if the seed bed is fine, moist and warm.

Planting.

The time of planting depends on the climate of the district in which the crop is to be grown. Planting must be delayed until all danger of frost is over, and the soil must be warm so as to obtain a rapid even germination. With too early planting the seed is likely to lie in the ground and rot, or if germination takes place it will be slow and give unsatisfactory growth.

October is early enough for planting in our main dairy belt, but planting may be continued well into December.

Rate of Seeding.

The seed may be broadcast at the rate of 30 to 60 lbs. per acre depending on the variety, but—for preference and economy—drilling is strongly advocated. When drilled in rows 3 feet apart, the rate of seeding will vary from 7 to 15 lb. per acre according to the size of the seed and variety. Sown in this manner the Black Seeded variety, which is recommended, will require 7 lbs. of seed per acre. The depth to sow the seed is from 2 to 3 inches as usually employed for maize.

Manuring.

Being a legume, the principal fertiliser required is superphosphate, providing that the necessary nitrogen-fixing bacteria are present. When planting, a small quantity of sulphate of ammonia is desirable, as the young plants will not have sufficient bacteria on their roots to supply nitrogen from the air. The mixture recommended is not less than 2 cwts. of superphosphate and 56 lb. of sulphate of ammonia per acre. Generally an application of 3 cwts. per acre of "Super and Ammonia No. 2" will supply the fertilising ingredients required.

Inoculation.

Cow peas, like other legumes, can obtain their nitrogen requirements from the free nitrogen of the air, which is fixed and made available to them by nitrogen-fixing bacteria. Inoculation, therefore, with the desirable specie of bacteria is essential, and cow peas cannot be a complete success without it.

"Cultures" for cow peas are being prepared in the laboratories of the Plant Pathologist of the Department, and applications for culture should be made to the Director of Agriculture, and accompanied by a fee of 1s. 6d.; this being sufficient to treat 40 to 60 lbs. of peas.

Cultivation After Planting.

Much of the success of the crop will depend on frequent cultivation to conserve the soil moisture and keep down weeds. The cultivations begin soon after germination commences and continues until the spread of the plant prevents further working, which is usually 5 to 6 weeks from date of planting.

Cow Peas and Maize grown by Mr. S. F. Russell, Serpentine.
Photo. taken 10 weeks after planting.

Growing in Conjunction with Maize.

One of the best ways to use the crop for fodder purposes is to grow the cow peas in combination with maize. Mr. S. F. Russell, of Serpentine, has demonstrated very successfully that yields up to 33 tons of green material per acre can be obtained from maize and cow peas. The accompanying illustration shows a crop ten weeks after planting. Sorghum also can be used in place of maize, and the rate of seeding for rows 3 feet apart would be 18 to 20 lb. maize or 10 lb. sorghum with 8 to 12 lb. cow peas per acre. Cow pea seeds may be sown in the same rows as maize, but it is believed preferable to sow in separate rows. The rate of growth of cow peas and maize is approximately the same, so that the alternate rows can be cut together, the mixture providing a succulent and high protein ration for milk production.

ARMILLARIA ROOT ROT OF FRUIT TREES. *

H. A. PITTMAN, B.Sc.Agr., Plant Pathologist.

Armillaria mellea, a fungus of world wide distribution, is by far the most important cause of root rot of fruit trees in this State. It is distributed right throughout the orchard areas, citrus trees being particularly affected, though it is found also on stone fruits, apples, pears, grapes, mulberries, passion fruit, and occasionally even potatoes.

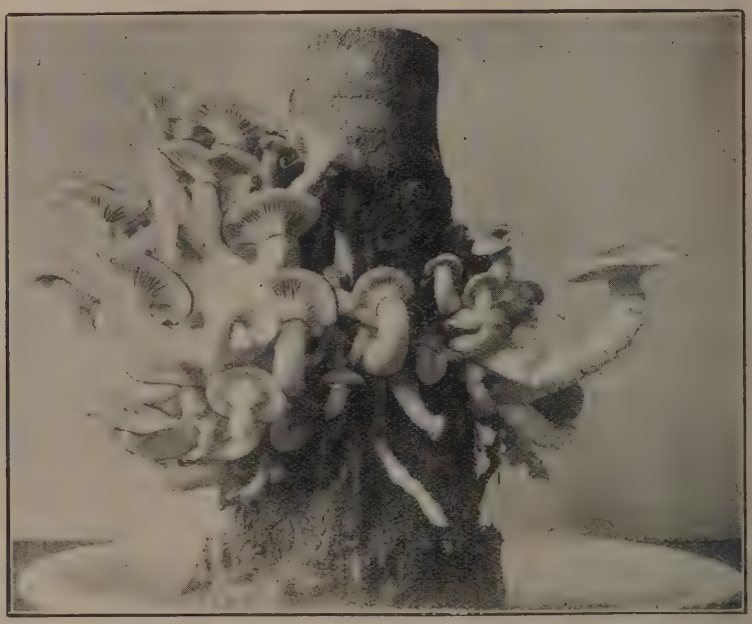


Fig. 1.—*Armillaria mellea* fruiting at the base of an orange tree which had been killed by the fungus.

After W. M. Carne, this "Journal," Sept., 1926.

The fungus is commonly present on the roots of native trees, and is especially prevalent in the red gum and jarrah country. It is rarely, if ever, of any consequence in orchards where grubbing-out of the roots and stumps has been efficiently done before planting the young trees, as it most often gains entrance to the living roots from decaying roots or other plant parts remaining buried in the soil after clearing.

SYMPTOMS SHOWN BY AFFECTED PLANTS.

The first indication of Armillaria root rot is a sickly yellow colour in the foliage and a tendency for the trees to become sluggish and to die back. If the soil is removed and the roots exposed it will be found that some at least of the roots

* Revised and reprinted after the article "Root Rot of Fruit Trees due to *Armillaria mellea*," by W. M. Carne, late Botanist and Plant Pathologist to this Department, which appeared in the September, 1926, issue of this "Journal," pp. 429-432, owing to the Leaflet (No. 192) embodying the matter of Mr. Carne's article now being out of print.

will be rotting to a jelly-like consistency. Black strands will be found running among the affected roots, half embedded in the tissues in the case of citrus, and running free on the surface in apples and stone fruit. The presence of these black strands (*rhizomorphs*) on the roots is a certain guide to the identification of the disease. If the bark of the affected roots, which becomes soft and loose, is removed, a layer of white fungal growth will be found between it and the wood. Rotting spreads to the butts of the roots and up the lower parts of the trunks. In an advanced stage of the disease clusters of mushroom-like bodies may be found, in the autumn and winter, at the base of the stem or where a root has been brought close to the surface of the ground. These are the fruiting bodies of the fungus. They are yellowish or brown above and whitish on the underside of the cap. The caps may be from one to over six inches across.

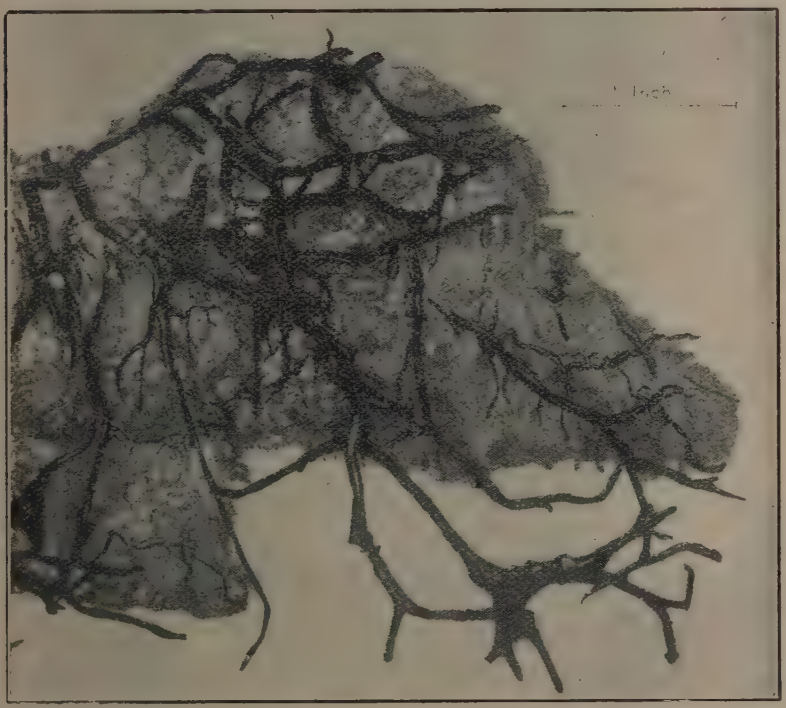


Fig. 2.—Rhizomorphs of *Armillaria mellea* on nectarine root.
Photo., N.S.W. Dept. of Agric.

The fungus causes a rotting of the roots so that the tree suffers from want of food. This leads to yellowing of the leaves, dropping of the leaves, and dying back of the branches. Frequently only the roots on one side are affected, and the tree may live for years. In bad cases most of the roots are affected, and the rot spreads to the base of the stems, working round until the trees are ringbarked. Death occurs usually in the dry season.

CONFUSION OF ARMILLARIA ROOT ROT AND COLLAR ROT.

Root Rot and Collar Rot are often confused. Collar Rot normally develops above the union of stock and scion, and does not extend down to the roots. No *rhizomorphs* are developed. Root Rot, on the other hand, starts with the roots and spreads up the stem from below ground.

Fig 3.—Rhizomorphs of *Armillaria mellea* on citrus roots.
Photo., N.S.W. Dept. of Agric.

Collar Rot is only of serious moment on soils which remain very wet for a considerable period, as, for example, after rains or irrigation, or as a result of the rise of flood waters or seepage from springs, etc. *Armillaria* may cause serious damage under soil conditions too dry to encourage Collar Rot.

METHODS OF INFECTION.

The principal and most important source of infection is the presence in the soil of roots or stumps of native trees, particularly the marri or red gum (*Eucalyptus calophylla*). This tree has its roots commonly affected with the parasite, which has no apparent bad effect upon its growth. Infection is most likely where land is planted from which green marri has been recently cleared. Wattles are also very liable to attack and suffer considerably.

In addition to the above-mentioned method of infection, the spores or seed bodies of the mushroom-like stage of the fungus may be blown to other trees and start infection.

Once a tree is attacked, the black strands (*rhizomorphs*) gradually work through the soil to the roots of other trees, and in the course of time a large number of trees may become infected from a single neglected diseased tree.

Fig. 4.—Rhizomorphs and young fruiting bodies of *Armillaria mellea* on Orange root.
After W. M. Carne, this "Journal," Sept, 1926.

PREVENTION AND TREATMENT.

1. As in all cases of disease, prevention is better than cure. Armillaria Root Rot in the majority of cases indicates rushed planting in improperly prepared land. It means that stumps have not been properly grubbed out or the roots followed up. Therefore, when clearing, make every effort to remove as many stumps, roots and branches of the native timber as possible from the soil so as to prevent subsequent attack.

2. If possible, grow vegetables (other than potatoes) or cereals for several years after clearing, so that any roots, etc., left may decay thoroughly before the orchard is planted.

3. See that the drainage is satisfactory, as bad drainage aids the fungus. Do not use bush drains, however, as these may harbour the fungus.

4. If a tree should become attacked in spite of all the previous precautions, or because of lack of them, carefully remove the soil from around the trunk so as to expose the main roots. Cut off affected roots, follow them up and remove completely. Then burn them.

5. Now cut away any rotted areas on the stem or butts of the roots, going well into the healthy wood both below, and all round, the diseased area. Then dust the wounded parts with sulphate of iron, or, better still, paint with *Bordeaux Paste*, made up as follows:—

Dissolve one and one-half pounds (1½ lbs.) bluestone in one (1) gallon of water. Slake three pounds (3 lbs.) of quicklime with another gallon of water. Then pour together and stir thoroughly before using. Apply with a brush as soon after the wound is made as possible.

When not in use the mixture should be kept in a closed container.

6. Then scoop the earth at the base of the tree into a saucer-shaped depression, about three feet in *radius* and pour in a solution of sulphate of iron made up at the rate of one pound of sulphate of iron to five gallons of water. Fifteen to twenty gallons (*i.e.* 3 to 4 lbs. sulphate of iron) will be required, according to the size of the trees, and the treatment is best given in the autumn or spring although it may be successfully used at other times also, provided the trees are not suffering from lack of moisture. When the water has soaked into the soil fill in the depression, *except for a hole, a foot or more in radius and nine inches or so in depth, around the trunk.* The tree should thus be left suspended on the butts of the main roots under and about which air should be free to circulate. This depression should be left open indefinitely to allow plenty of air and light to get at the base of the tree, as the *A millaria* fungus shuns light and air.

7. To assist the free penetration of light and air to the base of the tree, any very low-hanging branches on citrus trees should be cut back to two feet or so from the ground. (The tops of affected trees may also often be thinned out to advantage.)

The measures numbered 6 and 7 will prevent attack of the trunk, which is the most vital part of the tree. If the trunk and butts of the roots are preserved in a state of health, new roots can be formed from time to time to replace any which may be killed off by *Armillaria*, but a tree cannot form a new trunk.

8. Sprinkle three or four pounds (lbs.) of powdered sulphate of iron around that area of ground beneath, and a yard or so beyond, the spread of the branches, which has not been treated by the watering-in method already described, and either water it in or apply it just before rain, so that it will be readily dissolved and carried down to the roots.

9. Dust any *Armillaria* mushrooms lightly with sulphate of iron as soon as noticed, so as to kill them, and prevent the dissemination of the fungal seeds far and wide.

10. It may be possible at times to inarch one or more young trees into an old one which has been operated on, so as to keep up the flow of sap to the top of the tree, although this is usually more practicable in the case of Collar Rot or brown-rot gummosis, than in the case of Armillaria Root Rot.

11. It has often been recommended that the affected area of ground should be isolated, to prevent the spreading of the fungal *rhizomorphs* through the soil to healthy trees, by digging a trench two feet deep round the outermost limits of the infected zone. The trench should either be left open indefinitely or the soil within the trench should be repeatedly turned over and exposed to the sun. Such a procedure has not usually been found necessary in this State provided that the other recommendations have been satisfactorily carried out.

12. Trees treated as above have often completely recovered and continued to yield heavy crops for many years. If too far gone before the trouble is diagnosed, however, it is best to dig them up, burn them on the spot and treat the holes well with sulphate of iron, as recommended above, before other trees are planted, preferably also leaving the holes open for a considerable time before replanting. If the original stump or root from which infection started can be located this also should be dug out and burnt.

THE WILD TURNIP.

(*Brassica Tournefortii*, Gouan.)

By C. A. Gardner, Government Botanist;

WITH NOTES ON CULTURAL METHODS OF CONTROL,

By G. L. Throssell.

Weeds play a not inconsiderable part amongst the many burdens which the farmer has to bear, but of all the weeds which have proved most troublesome it is doubtful if any single species has proved so serious to the farmers of Western Australia as the wild turnip. Once it has become established on a farmer's holding much patience and labour are required in order to secure its eradication, and such results are rare. Much of the trouble can be traced to indifference in the early stages of the weed's aggressiveness, and the wild turnip, of all weeds, calls for prompt action and unceasing watchfulness. Like many of our weeds the wild turnip had small beginnings, escaping general notice until it had assumed such proportions that it became a menace, but had due care been exercised it is probable that an active campaign six or seven years ago would have either accounted for its extinction, or at least confined the pest to the original centre of its spread. That this is not the case can be traced to a great extent to ignorance and carelessness—ignorance in not recognising in the plant a serious weed, and carelessness in allowing it to spread so rapidly from centre to centre. Speaking of the present extent of the weed's distribution in Western Australia it is doubtful if any other plant has spread so rapidly with the single exception of the double-gee.

The purpose of this paper, in which the plant is described, together with a summary of its most objectionable features and methods of control and eradication, is the dissemination of what it is hoped will be useful information to farmers who are acquainted with the weed and desire knowledge of how to deal with the pest, and also to inform those who have not seen the plant, of its appearance and characteristics, so that prompt measures can be adopted when, or if, the plant appears in their midst. In fact to the latter class it is of the greater importance, since prevention is better than cure, and there is no reason why the present area of the weed should not be arrested, and even reduced. Care, however, is necessary, and in addition to individual action on the part of farmers it is also desirable in the interests of the community that roads boards and farmers should co-operate in the work of eradition. If the farmer is content to see the weed spread along the road, thinking it the business of the road board to deal with it, and vice versa, and both parties neglect its appearance on Government reserves, it is certain that the weed will become a problem of considerable importance in that district. Wild turnip is not a weed which penalises the untidy or careless farmer alone, for although he may be the principal sufferer he is also contagious, since his neighbours will always be under the necessity of keeping the weed in check. The appearance of wild turnip in an area previously free from the trouble is patently a matter for concerted action by all concerned.

The wild turnip, sometimes referred to as "roly-poly"—but incorrectly so, this name being bestowed on another plant—does not occur in any other State of Australia. We are ignorant as to the circumstances attending its introduction, and the period of this introduction, but it would appear that it first obtained a footing in Australian soil about 1916. It came from abroad, and it is thought by some that the seed was introduced from Argentina during the years

immediately following the drought year of 1914, when seed and produce were imported. Inquiries recently made in Buenos Aires has shown, however, that *Brassica Tournefortii* does not occur in that country to the knowledge of botanists there. Since the species is indigenous to the countries bordering the Mediterranean Sea it appears more probable that the first seeds came from Palestine, Egypt or Tripoli, where it is common. This, however, is a question which cannot be answered to-day.

For about ten years after its introduction the plant made but little progress. It is probable that during this period it was confused with charlock—a weed which is much resembles, or wild radish, and it is significant that the latter was gazetted a noxious weed for the Kellerberrin Roads Board district in 1927 without previous botanical determination: but neither wild radish nor charlock—weeds of long standing—have become so gregarious as wild turnip. The first official recognition of the plant was made in December, 1928, when a complete specimen was received at the Perth herbarium from the manager of the Merredin Experiment Farm. The weed was then stated to be spreading between Hine's Hill and Nangeenan. No reference was made in the available literature to the plant's capacity as a weed, and specimens were sent to the Kew herbarium for substantiation. In reply it was stated that the plant would probably spread extensively if it should find conditions suitable to its growth. This prediction proved correct, and during 1929 complaints regarding the spread of wild turnip were received from the Kellerberrin and Merredin Road Boards, and the plant was gazetted a noxious weed for the State of Western Australia on the 8th December, 1929. The serious nature of the plant was emphasised, and immediate control urged. It was during this season—the end of 1929 and beginning of 1930—that chaff from the affected areas was sent to other districts, and in March, 1930, the plant was collected by G. L. Throssell at Dowak Siding near Salmon Gums. Reports throughout the Salmon Gums district followed early in the winter, and during this same year it appeared on several railway sidings between Merredin and Salmon Gums. By the end of 1930 reports of the presence of the plant were received from districts as far afield as Marvel Loch, Narembeen, Mukinbudin and Koorda. This phenomenal spread must be attributed to the introduction of infected wheat, oats or chaff.

The present range of the wild turnip extends from Carnamah and Coorow in the north to Lake Varley and Lake King in the south; from Koorda and Kellerberrin in the west to the eastern rabbit-proof fence, and a separate centre affected by the weed extends from Widgiemooltha and Norseman through the mallee district as far south as Scaddan. It is worthy of note that the western spread of the weed has been slight except in the north, where in the Coorow district the seed is said to have been introduced through oats. This absence of a noticeable westward drift may be attributed to the absence of introductions of chaff and seed from the east rather than to assumed factors of grazing and unsuitable climate. That the weed will gradually spread westwards unless checked is inevitable, since the prevailing winds favour such a direction. Some centres to the west have, however, been affected, but are controllable. Reports of the presence of wild turnip have been received from Northam, but there are no specimens to confirm this, and it has also been stated that the weed is established on a small area to the south of Cunderdin, but here again the evidence is lacking the support of material. The plant has, however, appeared in the University grounds at Crawley, Perth, being undoubtedly introduced in chaff, but this area, after being subjected to experiment, will be controlled. It is worthy of note in connection with the Crawley specimens that the plants are dwarfed, and lack the vigour in the coastal sand that they possess in the firmer loam of the agricultural areas.

EXPLANATION OF PLATE V.

A. Leaf (half natural size). B. Young plant, showing primary and secondary leaves. C. Illustrating part of an inflorescence, and the general habit of the summit of the plant when in seed. D. Siliqua viewed from the side showing the beak and dorsal nerve of one valve. E. Section showing a siliqua with one valve removed and the seeds in position. F. View showing the ripe siliqua with the valves removed, the central partition with some of the seeds in situ, and the persistent beak. (Icon. origin.)

BOTANICAL DESCRIPTION OF PLANT.

Root annual, long and vertical, extending to 1.5 metres in length (four and a-half feet). Stems .10—2 metres high (4 inches to 6 feet) erect, flexuose, branching from the base, rarely simple, terete, clothed with stout unequal conical hairs in the lower parts, the hairs more slender upwards, all rectangularly spreading or almost recurved, glabrous in the upper parts, green, or often violet-coloured. Basal leaves rosulate, spreading to a diameter of .5 to .6 metres, shortly and widely petiolate, lyrate-pinnatisect, with 4—12 pairs of segments, the terminal segment almost obovate-orbicular in outline, obtuse and obliquely cordate at the base, ± 3-lobed, with intermediate lobes ± produced, otherwise crenate-dentate; lateral lobes gradually decreasing in size from above to below, the upper pairs ovate and crenate-dentate, the lower pairs oblong and entire, all auriculate at the base; stem leaves much smaller than the radical leaves setaceaus-hispid on both sides, especially on the mid-nerve, oblong or linear in outline, acute, entire or denticulate. Racemes contracted at the time of flowering, but elongating in fruit, 10—25-flowered. Pedicels short, 2—6mm. long, almost erect, glabrous or sparsely pubescent. Flowers small. Sepals 3mm. long, ± erect, the outer pair rounded-oblong, the inner sepals oblong-ovate, rather acute, green suffused with a violet-purple, glabrous, or sparsely hairy outside. Petals 5 -7mm. long, pale yellow, often violet on the claw, sometimes fading to almost white; the lamina oblong-obovate, slightly narrowed into a claw. Stamens 6, the inner 4.5mm., the outer 2.5mm. long, the anthers oblong. Ovary cylindrical, with 10—22 ovules in a single row in each cell; style 1mm. long; stigma as wide as the style.

Fruit on a rather long pedicel of up to 1 cm. in length or more, erect-spreading, sometimes almost divaricate, 3.5--6.5cm. long, 2.3—3mm. wide cylindrical with swellings and contractions (torulose), terminating in a usually long beak of 7—10mm., usually containing one, but sometimes 2 seeds, the valves of the fruit membranous, subemarginate at the apex, greenish-yellow, or sometimes violet-tinted. Seeds globular, 1—1.2mm. diameter, pale purple-brown in colour, the hilum black, alveolate, pendulous, but erect in the beak.

Flowering season, July to November.

The species belong to the Sect. *Brassicotypus*, Dumort, distinguished by the numerous ovules, large siliqua, conical beak as wide as the siliqua at its base, distinct stem which breaks away at maturity, and the 1—2-seeded beak. It differs from *B. oleracea*—"Cabbage," and *B. rapa*—"Turnip," in the stem-leaves not being amplexicaul, and in these respects from *B. campestris* also. From "Charlock" (*Sinapis arvensis*, Linn.—*Brassica sinapistrum*, Boiss.) the plant can be distinguished by the fewer and narrower stem-leaves, smaller flowers, fewer-flowered racemes, larger and wider siliqua which is 1-nerved, not 3—5-nerved as in *Sinapis arvensis*.

Habitat: Mediterranean Region, from Spain and Portugal to Sardinia, Sicily, Algeria, Tripoli, Lower Egypt, Greece, Smyrna, Syria, Palestine, Mesopotamia, Armenia, the Persian Gulf, and Baluchistan (N.W. India).

Brassica is a latin name for the Cabbage (*Brassica oleracea*, L.) used by Cato (De re rustica, 156, 157). *Tournefortii*, after Tournefort, a botanist who lived (1656-1708) before the time of Linnæus.

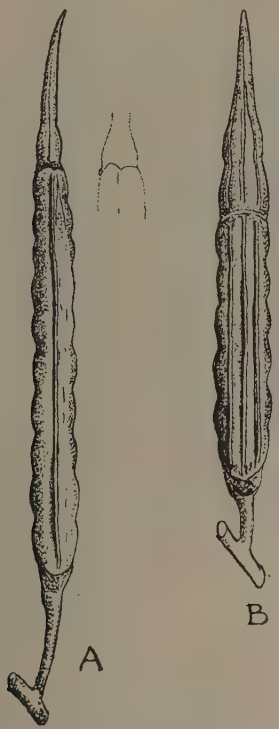
HABIT, AND SOME DISTINGUISHING FEATURES.

The first pair of leaves are small and heart-shaped, with the stalk attached to the apex of the heart. These are succeeded by a number of bristly-hairy leaves, small at first, but soon lengthening, and lying on the soil in a flat rosette, from nine inches to two feet or more in diameter.

In this stage the habit of the plant rather suggests a young cape weed (*Cryptostemma calendulaceum*), but an examination will reveal several differences. The young turnip has bristly-hairy leaves of the same colour on both sides, the leaf is more succulent, and when bruised there is a distinct scent of turnip. The plant is also tap-rooted. The cape weed has soft leaves, hairy on both sides, but more particularly below, where the leaf is grey with close hairs. There are no bristly hairs; the leaf is paler on the under side, and the roots are fibrous and numerous.

Wild turnip is more likely to be confused with wild radish or charlock. In its young state, it is almost impossible to distinguish the plant from charlock, but from the wild radish it can readily be distinguished by the position of the leaves; those of the radish are erect, and do not form a flat rosette.

When the stems are developed the differences are seen at a glance. Cape weed rarely, if ever, has an erect stem, and the stems are woolly-white with reddish, longitudinal lines. The radish stems are leafy, and so are those of charlock, but



VI.

Siliquas (fruits) of Wild Turnip (A) and Charlock (B).

not so leafy as those of the radish. Wild turnip has small stem-leaves, usually few in number, and they are narrow, not coarsely toothed like those of the charlock. The wild radish has stem leaves resembling those of the base of the plant, and they are not hairy, or the hairs are appressed. Rarely are the hairs spreading, and they are not as dense as those of the turnip.

In flower the differences are still greater. The wild radish and charlock have large flowers, those of the former being yellow, white or purplish-pink; those of charlock are a deep yellow. The wild turnip has small flowers of a pale yellow. The charlock has a swollen tap-root, often half exposed, and purplish in colour. It resembles, in short, a small turnip. The wild turnip has a slender tap-root. The

charlock also has more numerous flowers, and there are broad-toothed leaves on the stem. The wild radish has leafy stems also, but the leaves of the stem are not very different to the lower leaves.

II.

III.

Mature plant in seed. In this condition the plants are carried about by wind.

In fruit the three are still more distinct. The fruit (seed-pod) of the wild radish resembles a string of beads, being much narrowed between the seeds, and the fruit does not open, but breaks transversely between the seeds, each segment remaining entire with a seed inside. Charlock and wild turnip shed their seeds. The "pod" of charlock is one to two inches long, on a short stalk, and projects upwards, lying almost against the branch. Each valve (the part which falls off to liberate the seeds) is 3-5-nerved, and rounded at the top. The fruit of the wild turnip is on a longer stalk which projects from the branch at a decided angle, and is one and a-half to three inches long. The "valves" are prominently 1-nerved, with sometimes

IV.

Base of mature plant, showing how the stems separate from the root. Note absence of leaves at this stage.

two fainter nerves, one on each side of the central nerve or rib. The summit of the valves is broad and obtuse, and more or less notched. This character of the nerves of the valves, together with the shape of the stem-leaves, are the most important distinctions to be observed between charlock and wild turnip. The local specimens of charlock have three distinct nerves on each valve. A further distinction is the comparative length of the beak: in charlock this is approximately one-third the length of the fruit, while in the wild turnip the beak is less than one-quarter.

It is not certain whether charlock breaks off at the soil level when mature: the wild radish does not.

Some farmers may possibly confuse the common mustard (*Sisymbrium orientale*) with wild turnip, but the habit is quite different. The stems are leafy with smaller divided leaves, and the small yellow flowers are succeeded by long narrow cylindrical pods with minute numerous seeds. There is no "beak" at the tip of the "pod."

WILD TURNIP AS A WEED.

The characteristics which render the wild turnip so objectionable as a weed are briefly the following:—

The leaves, spreading flat on the ground in a rosette, crowd out or prevent the growth of other plants within their circumference. The area thus covered is often considerable. The characteristic of the breaking away of the stem at maturity renders the plant a mobile instrument of seed dispersal. The large seed production —often some thousands of seeds—makes even a single plant a serious source of infestation. The presence of the beak on the fruit ensures the establishment of new plants wherever the parent plant ultimately rests. This may be a considerable distance from the place wherein it grew. Added to this is the probability of these appendages to the seed vessel being broken off in transit, making the distribution even larger. The longevity of the seeds is another undesirable characteristic. The period of viability is not definitely known, but it is safe to assume that they possess the power to germinate after several years in the soil. The plant is vigorous and thrives in almost all situations. Added to this is the ability of the plant to produce seeds in a short period, even after the stems have been cut down. Short stems may be produced after injury, and these produce a number of fruits in a short time. This is noticeable where the plants have been grazed, where specimens three or four inches in height have produced seeds. The period of flower and seed production is prolonged. Wild turnip may commence seeding within one month after germination, continuing until the late spring. Plants eradicated when in an advanced stage of flowering can ripen their seeds after removal from the soil. The long tap-root enables the plant to thrive in soils too dry for many common weeds, and lastly the fact that the plant is not readily eaten by stock to any extent renders it serious. All of these characteristics make the wild turnip a weed amply provided for, and difficult to abolish after establishment.

AGENCIES FAVOURING DISTRIBUTION.

Although wild turnip is naturally spread through the agency of wind, the dead plants being carried considerable distances along the ground, or even being lifted into the air by strong winds, scattering their seeds in transit, it is not by this means that the plant has made such a phenomenal invasion of our wheat country. Had its spread been limited to natural methods, the area would still be comparatively small. The introduction of the plant from one centre to another has been made almost entirely through wheat, chaff and oats. Seed wheat and chaff were responsible for the distribution of the plant eastwards to the Esperance Railway as far as Dowak, while oats are said to be the means of its introduction into the Midlands areas. The presence of the seeds in chaff was probably responsible for the appearance of wild turnip in the vicinity of railway sidings between Widgiemooltha and Norseman, and quite recently the discovery of the weed in the University grounds at Crawley, Perth, leads one to suppose that the seeds came there in chaff used by horses. It is thus important that farmers purchasing chaff or seed wheat, obtain the former from weed-free areas, and where wheat is purchased from

such areas the grain should be graded, thus eliminating the risk of wild turnip seed contamination. This is also a point in favour of obtaining graded pedigree seed.

Harvesting or reaping machinery borrowed from weed-infested holdings is undoubtedly a source of seed dissemination. Live stock, by ingesting the plants, may also play an important part in this respect. Motor vehicles may also be instrumental in spreading the plant, if they travel through areas of wild turnip. Seeds are probably shed on the running boards or other places, and deposited elsewhere. Cars with portions of the weed adhering to springs, etc., have been noticed.

ERADICATION AND CONTROL.

i.—*Prevention of Wild Turnip in Weed-free Areas or Holdings.*

It is of primary importance that one should be able to recognise wild turnip. Much of the foregoing will be useful in this respect. If any doubt exists, specimens should be submitted for diagnosis. One plant, if left untouched, is sufficient to produce numerous plants in the following season. The recognition of the plant is therefore of the utmost importance. The appearance of wild turnip in a new district should be a matter for concerted action. The plant may first appear on the roadside, and such places are quite as dangerous as cultivated land. It is in the interests of road boards and farmers to deal immediately with the weed upon its first appearance. The plant when it first appears should be pulled up and burned. Due precautions should be observed in connection with the purchase of chaff, seed, and poultry food from unknown sources, and this applies also to the purchase or loan of stock, especially horses from areas where the weed may exist. Borrowed harvesting or reaping machinery should be carefully cleaned before using. Motor vehicles from infested areas should not be permitted the continual use of private roads through a clean holding.

The provision of wind-breaks, or strips of scrub or trees inside the boundary fence is a useful precaution, both in clean areas as well as infested. Scrub provides an effective barrier against an invasion, the turnip plants being heaviest at the base, drive into the scrub and are held there. They can be removed and unless the soil is light, the germination of seeds is small. In any case a watch can be kept over the place where plants are discovered. In addition, such wind-breaks are useful in protecting crops, minimising soil erosion through wind, and providing firewood for the future. Eleven yards is the minimum useful width of such wind-breaks. It should be remembered that a fence, whether wire or netting, is no barrier to the progress of the weed. Finally, keep a watch along roadsides. These are common sources of infestation. Do not leave the matter to the attention of the roads board. When eradicating the plant remember that if seed-vessels are already formed, or even if the plant has matured flowers, it should be destroyed. It is useless to pull out such plants and leave them in situ.

ii.—*Mechanical Methods of Control.*

The plant should be pulled out completely or hoed below the surface of the soil. Young plants may remain on the surface, but mature plants should be collected, and either buried deeply or burned. When collected, such plants should be placed in a bag. Shaking will liberate seeds from mature seed-vessels. It is wise to acquire the habit of recognising the weed in its early stage of growth.

iii.—*Cultural Methods of Control.*

In the summer or autumn preceding fallowing it is a good plan to cultivate the land lightly. This causes the seed to be covered, and a good germination may be produced in readiness for the initial operation of fallow-

ing. Paddocks which are to be fallowed should be stocked heavily. Sheep will do much towards keeping the weed in check, since they eat the plants with avidity when young, provided that other feed is present. Such stocking will also ensure a better turning in of the weeds during fallowing. Land should be fallowed early, before the weeds have made much growth. A minimum depth of 3 to 4 inches is desirable, since it is impossible to do uniform or effective work at a shallower depth. On the heavier classes of soil it is obvious that the lighter types of cultivating ploughs are unsuitable for a thorough initial ploughing. If sufficient sheep are available for grazing and they can keep the weed in check, it may be possible to complete the whole area to be fallowed without the earlier ploughed land receiving further attention. Where this is not the case it is advisable to cultivate a portion of the fallow while the weeds are young, and before the whole area to be fallowed is completed, since greater success is obtained by treating the weeds in the young stage. Fallowed land should be again cultivated during the spring, and should summer or autumn rains produce new growth, harrowing or cultivation should be resorted to.

Where the weed is only occasionally present, hoeing or pulling is the most satisfactory method of dealing with it. It is, however, important that infected spots should be examined during the next year, since ungerminated seeds may be present when the plant is removed.

Infested crops should never be used for hay, since this is a certain way of distributing the plant. Before the cereal is in a stage suitable for cutting, the turnip is certain to be either in seed or in a condition capable of seeding. If clean land is not available, the weed should be eradicated from the hay crop by hand. Since it is unlikely that all plants will be removed by this method, it is wise to watch for plants while reaping. Any plants seen should be removed before being cut.

During harvesting, the attachment of a roller to the machine, either under the comb, or behind, provides a means whereby the stems are flattened out, thus reducing the risk of dissemination by wind.

The stubble should afterwards be burned as soon as permitted under the Act. Any plants which have accumulated along fences should also be collected and burned.

Seeding operations should be delayed until after the advent of seeding rains. In paddocks which are badly infested with the weed it is advisable to cultivate after the first rains, delaying seeding operations for at least another week, so that further seeds which may have germinated in the interim can be destroyed when seeding takes place. The cultivation preceding seeding should be deep enough to eradicate the weeds, but not so deep as to destroy the consolidation. Two inches is usually a sufficient depth.*

Cultivated land near fence lines should either be cropped, or eradication should be performed, since the wild turnip usually grows prolifically in such spots. Fence lines are often the resting places for turnip plants in transit.

Badly affected uncropped areas should be rolled and burned. It is dangerous to leave such patches untouched for any lengthy period of time. They are the centres of distribution from which areas are seeded by the weed.

Abandoned farms are a grave source of infestation. A holding on which turnip is present but not controlled remains a menace unless some action is taken towards its destruction. Burning at least, is desirable, since it kills many of the seeds.

WILD TURNIP
(Brassica Tournefortii)
Map, showing Distribution
1933.

Areas affected according to reports 1929.
ditto 1930
ditto 1933

Jerenjori
Camamah
Coorow
Moiya
Kalannie
Kulja
Bonnie Rock
Lake Brown
Campion
Northern Cross
KALGOORLIE
Coolgarlie
Hill
Merredin
Widgiemooltha
Northam
PERTH
Bruce Rock
Hyden
Lake Grace
Dowak
Salmon Gums
Narrogin
Newdegate
Wagin
Ravensthorpe

CHEMICAL CONTROL.

There are several chemical preparations on the market which probably would be efficacious in destroying wild turnip, but with many of these the cost is prohibitive. Examples are sodium chlorate and calcium chlorate, the cost of which is uneconomical. Experience in England has shown that two sprays are quite positive in action on charlock, these being *sulphuric acid* and *copper sulphate*. The formed was first used is France in 1911 by Rabate, and its use has increased until now several thousand acres are treated annually.

Commercial sulphuric acid (brown oil of vitriol) is mixed with water to give a solution varying from 7 to 10 per cent. in strength, and sprayed over the land by means of a suitable machine with acid resisting parts. From 100 to 150 gallons of liquid is sprayed on to the crop per acre. The best results are obtained when the charlock is in the four-leaf stage, but the treatment is also successful when the plants are several inches in height. The wheat or oat plants of the crop are not affected by this spray. If applied in bright weather the whole field turns brown within an hour of spraying, and in a few days the cereal recovers, and soon presents a healthy appearance.

The cost of the material is cheap, commercial *sulphuric acid* being the same price as bluestone (*copper sulphate*).

The copper sulphate treatment employs a somewhat more dilute mixture, 3 to 5 per cent. of bluestone being used in water, and applied at the rate of 50 gallons per acre. The treatment must be done during fine weather. It is a cheaper method than the *sulphuric acid* method, but is not so popular in Britain because of the necessity of fine weather during, and for several hours after application. Cereal crops are not injured by this treatment.

These practices necessitate the employment of large power sprays, and are not advocated at the present time, since local experiments have not yet been conducted upon wild turnip. It is anticipated, however, that because of the similarity between the two plants, there is every chance of success with such sprays.

BIOLOGICAL CONTROL.

There are no known reliable methods of biological control of wild turnip. Three species of aphids, *Aphis pseudo-brassicae* (stock aphis), *A. brassicae* (cabbage aphis) and *A. persica* (green peach aphis) attack the plant to a greater or less extent, depending upon favourable seasonal conditions. Should they appear in plague form a certain amount of destruction would be accomplished, but as a reliable permanent factor in the control of wild turnip, they cannot be relied upon.

EXPLANATION OF ILLUSTRATIONS.

I.—Map showing the known distribution of Wild Turnip from 1929 to 1933.

II.—Diagram or habit of young plant showing leaf-rosette.

III.—Photograph of mature plant in seed. Note its leafless nature at this stage. In this condition the plant is carried by wind.

IV.—Photograph of basal portion of the plant when mature, showing how the base separates from the root.

V.—Brassica Tournefortii. Showing leaf, flower, head of a branch in seed, structure of siliqua (seed vessel) and young seedling.

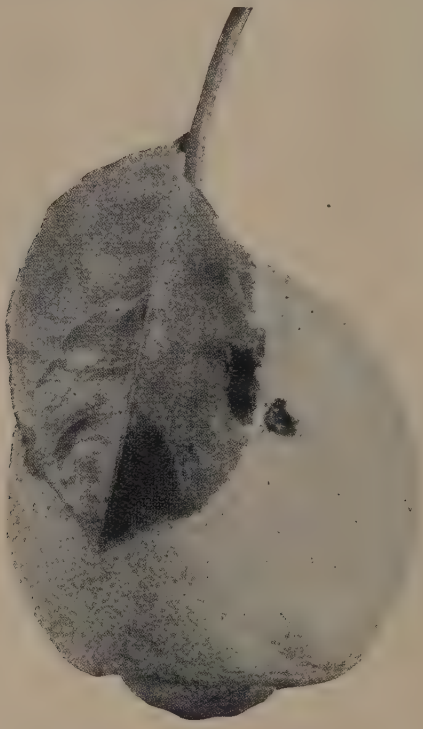
VI.—Diagram of the fruits of (A) Wild Turnip, and (B) Charlock. Note the comparatively short and slender beak of the Wild Turnip, the slender stalk, and the one-nerved valves. Notice the long and broad beak of charlock (almost half the length of the fruit), the three-nerved valves, and the short thick stalk.

CITRUS PIT.*

H. A. PITTMAN, B.Sc.Agr., Plant Pathologist.

This is an old established bacterial disease of citrus which is always with us, but which, in most seasons, is of little importance.

First described by Smith in California in 1913,† it was recognised in South Australia in 1924,‡ and was recorded for the first time for this State in 1926 by Mr. W. M. Carne, late Botanist and Plant Pathologist of this Department, now Senior Plant Pathologist, Commonwealth Council for Scientific and Industrial Research.



Lemon Fruit and Leaf with Citrus Pit caused by *Pseudomonas citriputeale*.
(After Fawcett, Horne, & Camp.)

Citrus Pit occurs most commonly on lemon fruits, and to a lesser extent on oranges and mandarins. With us, lemon leaves are apparently more frequently attacked than those of oranges or mandarins, though the reverse appears to be

* Revised and reprinted after the article "Citrus Pit," by W. M. Carne, late Botanist and Plant Pathologist to this Department, which appeared in the September, 1926, issue of this "Journal," pp. 378-381, owing to the Leaflet (No. 191) embodying the matter of Mr. Carne's article now being out of print.

† Smith, C. O.—Black Pit of Lemon—Phytopathology III., 1913, pp. 277-281.

‡ Lewcock, H. K.—Prelim. Note on a Citrus Bacteriosis in South Australia—A.A.A. Science XVII., 1926, p. 746.

the case in California.* There the twigs are also affected, and to this and the leaf attack the name Citrus Blast has been given. Twig attack has not been noted here.

On lemon fruits the spots are depressed, dry, circular, angular or oval, reddish-brown, brown or black, from very small up to three-quarters of an inch in diameter. Under wet conditions secondary organisms such as Blue Mould, Dieback (*Colletotrichum gloeosporoides*) and Sour Rot (*Oospora citri aurantii*), may extend

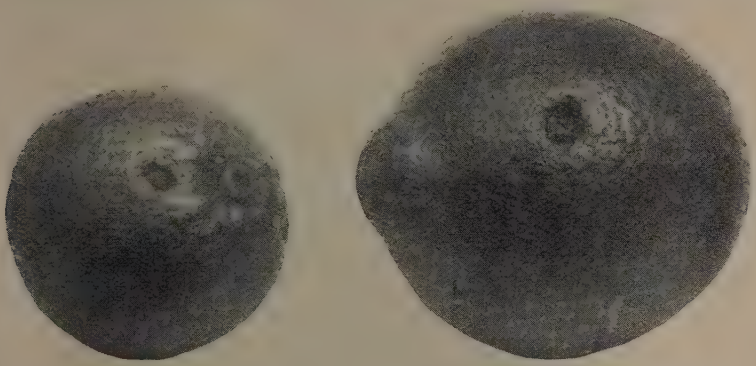


Fig. 1.—Lemon Fruits affected with Citrus Pit due to the bacterium *Pseudomonas citriputeale*.
After W. M. Carne, this "Journal," Sept., 1926.

the affected area over one-half the fruit or more, and cause a soft rotting. Under more normal conditions the spots are hardly conspicuous enough to seriously affect the sale of fruit.

On oranges and mandarins the spots are usually reddish-brown and smaller. They may run together, however, and form irregular, dry, brown areas.

The spots are confined to the rind of the fruit, and the edible portions are not affected unless secondary infection follows the primary attack. Indeed it may be said that the disease is only of importance when climatic conditions favour the secondary rotting organisms.

On leaves, infection is indicated by a blackened area, usually on the side or tip but occasionally central. There is a similarity to the leaf trouble caused by Brown Rot, but the edges of the blackened areas are less distinctly defined. The affected areas tend to dry and crack, and the leaves fall readily.

Experiments by Mr. W. M. Carne indicate that infection can be readily obtained when the tissues have been broken by pricking or otherwise injured. His attempts to infect sound fruit failed. This is in conformity with the American experience* that the bacterium is essentially a wound parasite, rarely, if ever, able to penetrate sound tissues. Fresh scratches and rubbings while the fruit is wet, with moderately low temperatures, ensure ready infection. It follows, therefore, that the trouble will be greatest in orchards exposed to much wind during wet winters. The present author has noted that this disease may cause considerable discolouration of the wounds made in citrus fruits by hail storms.

* Fawcett, H. S., Horne, W. T., and Camp, A. F.—Citrus Blast and Black Pit—University of California, Agric. Expt. Stn. of College of Agric. Technical paper 5, 1923, pp. 1-24.

CONTROL.

The trees should be protected from winds by wind-breaks as far as possible and dead wood should be consistently pruned out.

American investigations have shown that bushy compact trees are less liable to wind injury than those of more straggling growth. It has been found in this

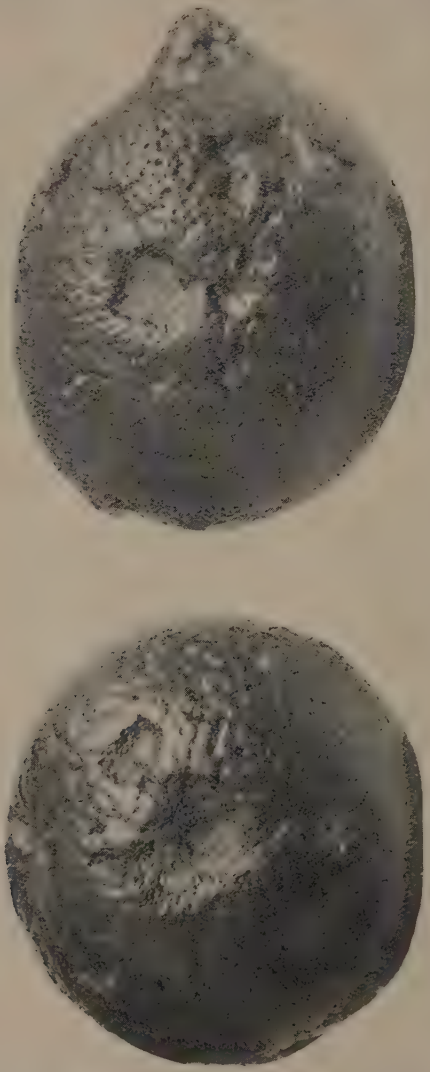


Fig. 2.—Orange and lemon with Citrus Pit due to attack by *Pseudomonas citriputeale*. *After W. M. Carne, this "Journal," Sept.*, 1926.

State that this disease is readily controllable by the routine autumn and early spring sprayings with 4-4-50 home-made Bordeaux mixture for Brown Rot. (See Leaflets Nos. 354 and 314, 2nd edit.)

LIVE STOCK AND MEAT.

For the information of readers of this "Journal," the following particulars have been supplied by Messrs. Elder, Smith, & Co., Ltd., Perth:—

COMPARATIVE NUMBERS OF STOCK SOLD AT METROPOLITAN FAT STOCK MARKETS FOR MONTHS OF JUNE, JULY, AUGUST, 1933.

	JUNE.				JULY.				AUGUST.				
	7th.	14th.	21st.	28th.	5th.	12th.	19th.	26th.	2nd.	9th.	16th.	23rd.	30th.
Sheep...	8,768	7,304	11,747	10,397	8,797	11,258	10,263	9,566	10,263	13,184	12,347	12,133	12,182
Cattle...	466	462	429	637	622	543	593	350	452	328	668	529	627
Pigs ...	1,587	1,168	1,575	1,346	1,368	1,510	1,596	1,889	1,440	1,360	1,447	2,204	1,427

COMPARATIVE VALUES PER POUND.

Mutton	4½d.	6d.	4½d.	4½d.	4½d.	4½d.	4½d.	5½d.	5d.	4½d.	4½d.	4½d.	4½d.
Beef ...	6½d.	6½d.	6d.	4½d.	4½d.	4d.	4d.	5½d.	5½d.	5½d.	5½d.	4½d.	4d.
Pork ...	6d.	6d.	6d.	6d.	6d.	6d.	6d.	5½d.	5½d.	5½d.	5½d.	5½d.	5½d.
Bacon...	4½d.	4½d.	4½d.	4½d.	4½d.	4½d.	4½d.	4½d.	4½d.	4½d.	5d.	5d.	5d.

MARKET REPORT.

Messrs. H. J. Wignore & Company, Limited, of Wellington Street, Perth, have supplied us with the following information regarding the chaff available for auction at the Perth Railway Yards, for the period June to August inclusive.

June.—720 tons of chaff. F.a.q. to prime wheaten chaff was making from £4 17s. 6d. to £5; f.a.q. from £4 10s. to £4 15s. per ton. Mediums were selling at £4 5s. Prime oaten chaff was changing hands from £4 12s. 6d. to £4 15s.: f.a.q. from £4 7s. 6d. to £4 10s. per ton.

Oats.—Good heavy feeds were finding buyers from 2s. 1d. to 2s. 5d.; good feeds from 1s. 11d. to 2s.; light feeds from 1s. 8d. to 1s. 10d. per bushel.

Wheat.—F.a.q. was selling at 3s. 4½d.; second grade from 2s. 9d. to 2s. 10d. per bushel.

July.—1,015 tons of chaff. The market for both wheaten and oaten chaff remained unaltered.

Oats.—Good heavy feeds were finding buyers from 1s. 11d. to 2s. 1d.; good feeds from 1s. 8d. to 1s. 10d. per bushel.

Wheat.—At the beginning of the month f.a.q. was making 3s. 3½d., second grade 2s. 11d. per bushel, but towards the end of the month the market advanced considerably, f.a.q. found buyers at 3s. 6½d., second grade 3s. 2½d. per bushel.

August.—600 tons of chaff. F.a.q. to prime wheaten chaff was selling at from £5 to £5 5s.; f.a.q. from £4 15s. to £4 17s. 6d. per ton. Prime oaten chaff was in demand at around £4 15s. to £4 17s. 6d.; f.a.q. at £4 12s. 6d. per ton.

Oats.—Good heavy feeds found buyers from 2s. to 2s. 2d.; good feeds from 1s. 9d. to 1s. 10d. per bushel.

Wheat.—F.a.q. was realising from 3s. 1d. to 3s. 4d.; second grade 2s. 11d. per bushel.

METEOROLOGICAL INFORMATION.

STATIONS.	TEMPERATURE.				RAINFALL.		TEMPERATURE.				RAINFALL.		TEMPERATURE.				RAINFALL.	
	Maximum.		Minimum.		For Month.	Average.	Maximum.		Minimum.		For Month.	Average.	Maximum.		Minimum.		For Month	Average.
	Mean.	Highest.	Mean.	Lowest.			Mean.	Highest.	Mean.	Lowest.			Mean.	Highest.	Mean.	Lowest.		
	JUNE, 1933.						JULY, 1933.						AUGUST, 1933.					
					inches.	inches.					inches.	inches.					inches.	inches.
Chapman State Farm	67·9	75·2	50·4	42·3	5·64	4·21	64·8	73·8	44·2	38·0	2·57	4·01	67·7	75·5	45·9	39·9	3·86	2·75
Geraldton	70·5	74·2	56·4	45·8	6·23	4·76	67·1	72·5	49·3	41·5	2·57	3·92	69·5	75·4	52·5	46·5	3·85	2·89
Walebing	65·1	75·1	47·5	37·2	5·12	4·01	60·0	67·0	40·7	34·0	2·71	3·80	62·2	70·0	42·0	32·0	3·33	3·12
Perth	65·8	74·2	53·3	43·1	6·52	7·02	62·4	70·8	46·3	37·6	4·99	6·77	63·4	70·8	47·8	38·8	5·67	5·74
Kalamunda	62·2	69·2	52·2	43·5	8·26	8·19	56·1	68·5	44·4	37·9	5·61	8·71	60·7	68·9	45·8	38·1	7·07	6·90
Bunbury	64·9	70·1	53·3	40·0	7·41	7·18	62·2	66·0	46·1	36·0	4·24	6·87	63·1	69·0	45·7	38·4	4·95	5·27
Bridgetown	62·9	68·8	45·9	30·0	10·99	5·92	59·6	67·0	40·1	31·0	5·24	5·81	61·3	69·8	39·4	28·5	5·06	5·10
Albany	62·9	69·0	50·4	42·2	8·79	5·43	60·3	65·8	46·1	38·4	4·80	5·61	61·0	71·3	45·9	37·8	4·97	5·29
Merredin State Farm	63·1	70·3	46·4	34·5	2·13	2·02	59·3	65·9	37·8	28·1	1·28	2·24	61·2	68·1	41·0	32·0	1·51	1·52
Northam	65·8	73·0	47·3	36·4	1·06	3·27	62·4	69·0	39·8	32·0	1·93	3·52	63·6	72·1	42·0	34·2	2·21	2·62
York	65·2	73·0	47·2	36·0	3·01	3·32	61·6	67·0	38·8	29·0	2·04	3·45	63·4	73·0	39·7	32·0	2·12	2·84
Narrogin State Farm	60·3	66·4	47·3	34·3	3·95	3·40	57·0	62·7	40·1	30·0	2·30	3·77	58·6	65·6	40·6	32·0	2·45	2·94
Katanning	60·8	65·0	47·9	35·3	5·43	2·94	57·5	62·0	43·5	35·0	2·07	3·13	58·8	66·6	10·8	30·0	2·43	4·72
Cape Leeuwin ...	64·0	70·0	54·8	46·0	12·44	6·91	61·3	66·8	51·5	42·5	7·87	7·30	60·9	68·8	54·9	43·5	5·35	5·75

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